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ABSTRACT

This review of research on gender differences in computer use at the elementary and secondary levels outlines the problems, discusses reasons for these problems, and gives suggestions for interventions to improve the situation. The research reviewed was conducted, for the most part, in the United States, Canada, Australia, and the United Kingdom. The review begins by stating the problem and considering who is using computers both at school and at home. Attention is then focused on reasons for the differences found, including association of computers with mathematics, the nature of computer courses, different behavior patterns of boys and girls, the social context of the classroom, the orientation of available software, and the influence of parents and role models. Teaching strategies suggested in the literature that address these problems are also described, and suggestions are made for surveys at the elementary and high school levels in Ontario (Canada). The annotated bibliography that makes up more than half of this report is divided into three sections: (1) studies of gender issues in education that relate specifically to computers; (2) studies that deal with similar gender differences in mathematics and science; and (3) studies of cultural factors and sex-role stereotyping. The results of a survey of recent or ongoing research related to gender equity issues in computer education in Canada, the United States, the United Kingdom, and Australia are also reported. (MES)

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Equity in Education: Gender Issues in the Use of Computers

A Review and Bibliography

Education and Technology Series

Sean Conway, Minister
Bernard J. Shapiro, Deputy Minister

Ministry of Education
Ontario

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Equity in Education: Gender Issues in the Use of Computers

A Review and Bibliography

Education and Technology Series

Barbara G. Moore

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CONTENTS

Section		Page
I.	INTRODUCTION	1
II.	WHO USES COMPUTERS?	1
	At School	1
	Out of School	2
III.	REASONS FOR DIFFERENCES	3
	Computers as Male-oriented Phenomena	3
	Association of Computers with Math	4
	Nature of Computer Courses	5
	Different Behaviour Patterns of Boys and Girls	6
	The Social Context of the Classroom	7
	Software	10
	Influence of Parents	11
	Influence of Role Models	11
IV.	TEACHING STRATEGIES SUGGESTED IN THE LITERATURE	12
	Removing the Image of the Computer Room as "Male Turf"	13
	Using Computers Across the Curriculum	13
	Reorganizing Computer Programming Courses	15
	Becoming Aware of Different Behaviour Patterns in the Classroom	16
	Making Teachers Aware of the Social Context of the Classroom	17
	Assessing Software Packages for Sexism	17
	Making Parents Aware of Problem	18
	Making Students Aware of Sex-role Stereotyping	19
	Holding Workshops for Teachers	19
	Conclusion	20
V.	SUGGESTED SURVEYS: ONTARIO	21
	Surveys at the Elementary Level	21
	Surveys at the High School Level	22
	APPENDIX A: Annotated Bibliography	23
	APPENDIX B: Research Inventory	60

I. INTRODUCTION

A considerable amount of research undertaken over the past ten years indicates that there are differences between males and females in access to, attitudes towards, and use of computers particularly at the intermediate and high school levels. Most of the available research has been conducted in the United States, Australia and England. However, recent research in Canada tends to reach similar findings.

Computers are commonly identified with the areas of mathematics and science, areas in which for many years there has been widespread concern about sex-related differences. It is not surprising, therefore, to find similar differences emerging in the area of computers. These differences between males and females do not appear to be due to differences in abilities, but rather to cultural and societal factors that promote sex-role stereotyping and impede computer access and use for some students.

The reluctance of many girls to take computer courses at the high school level has wide-ranging implications for their future education and job prospects. It is estimated that by the time the present students enter the job market 50%-75% of the jobs will involve computers in some way (Sanders, 1984). The number of women in the Canadian work force is rising steadily. At present women comprise 51% of the work force but hold 75% of the low-paying positions (Kruger, 1985). Women with children can expect to spend at least twenty-five years in the work force. If they wish to increase their economic status they must acquire the skills needed for non-traditional jobs, many of which involve computers.

The importance of involving girls in computer education must be communicated to teachers, principals, school administrators, students, and parents. Strategies to ameliorate the situation can then be put into place and evaluated to make sure that girls receive the help and encouragement they need to become involved with computers.

II. WHO USES COMPUTERS?

At School

Surveys of classroom enrolment patterns consistently show that girls and boys do not participate equally in computer classes (Project on Equal Education Rights, 1984). A 1982 nationwide poll of 17-year-old students in the United States showed that boys outnumber girls by two to one in high school programming courses (Kolata, 1984). Similar enrolment patterns are seen in the United Kingdom. Girls represented only 29% of the students taking the 1980 Ordinary Level examinations for 16-year-olds in computer studies. At the Advanced Level the number dropped to 21% (EOC, 1983). At the time of writing, statistics for the whole of Ontario were not available, but the figures for one large urban school board show a similar trend. The percentage of girls in Grade 10 advanced level introductory computer studies courses was 39%, dropping to 36% in Grade 11 courses and 18% in the Grade 12 computer science courses. The

percentage of girls taking computer technology courses at both the advanced and general levels was only 7%. (Principals' Reports, Ontario Ministry of Education, September 1985). In addition, boys dominate high school computer rooms before and after school and at lunch time. A study of American high schools by the Educational Testing Service found that while 60% of the boys taking computer courses used the computer rooms outside of class time, only 8% of the girls availed themselves of this opportunity (Sanders, 1984).

This difference in computer use is not confined to high school students. Studies of optional computer use in middle schools conducted by the Computer Equity Training Project showed that, prior to the implementation of intervention strategies, 78% of the students who took advantage of free time computer use were boys (Sanders, 1985). Often the computer rooms resembled boys' clubrooms. Many researchers indicate that the decline in computer use by girls becomes very noticeable in the middle school years (Alvarado 1984; Becker, 1985; Collis, 1984; Moore, 1984). Henry Becker of Johns Hopkin University spent three years collecting data about computer use in the classroom. He estimates that in all the schools observed during that period, approximately half of the first grade students interested in learning computer programming were boys; by sixth grade the proportion increased to about two-thirds; by ninth grade, more than four-fifths of the interested students were male (Watt, 1984).

Research at Queen's University into the creative use of computers at the elementary school level showed differences in computer use by Grade 7 boys and girls and tentative evidence in some earlier grades (Carmichael et al., 1986). When the researcher asked for the names of Grade 1 students who had frequently used the computer during the previous year, all the names given were boys'. In the same study, an observer noted that some Grade 1 boys would return to the computer two or three times in a morning, whereas girls would use the computer just once. However, it should be noted that other researchers report no differences in computer use between boys and girls in the early grades (Lopinski, 1984; Piestrup, 1981).

Out of School

Disparities in the use of computers away from school are important because they can affect use and performance in school. Students with access to a computer at home or at the home of a friend have time to practise and opportunities for trial and error. Such students can become more familiar and comfortable with the computer. The presence of other people, such as friends, siblings, or parents may provide help and advice, thus reducing anxiety surrounding computer use (Eaton, 1985).

Boys not only have the advantages of more computer time at school but they are also more likely to own or have use of a computer at home. Social scientists at the University of California, Berkeley, reported that among students in the state who had computers at home, boys outnumbered girls by 25%. In addition, boys used the computers at home more than girls (Miura and Hess, 1983). Among 459 seventh and eighth grade students in the Computer Equity Training Project test schools 37% of the boys reported having a computer at home, compared to 28% of the

girls. Of students with computers at home, 11% of the girls, but only 3% of the boys, said they did not use them at all (Sanders, 1984). When asked who used the computers the most in their homes, the boys were more than three times as likely as girls to say they used the computer most at home (Sanders, 1985). In the Queen's University Creative Uses Project, a higher percentage of boys at each grade level had access to a computer at home. At the end of their second year in the project, all the boys in one class had a computer at home, compared to 50% of the girls (Carmichael et al., 1986).

In addition to having access to a computer at home, or at the home of a friend, boys are more likely to enrol in computer courses outside of school and to attend summer computer camps. A survey was made of directors of summer camps and classes in the United States offering training in computer programming. It showed an enrolment pattern three to one in favour of boys for all grade levels. When enrollment was analysed by course level, the proportion of girls taking courses at the beginning and intermediate levels was 28%, at the advanced level 14%, and at higher levels 5%. The proportion of girls enrolled in these courses declined as the cost of the course increased (Muira and Hess, 1983). A survey of summer computer camps across Canada showed that boys outnumbered girls two to one (Johnson, 1983).

It is clear from the above evidence that boys are getting more computer time than girls, both at school and outside of school, giving them many advantages over girls in acquiring knowledge of computer learning environments.

III. REASONS FOR DIFFERENCES

Computers as Male-oriented Phenomena

Computers are frequently seen by children as "machines" to be dealt with by males. Throughout childhood, girls have less experience with machines than boys, and tend to be afraid of making mistakes with them, or breaking them (Sanders, 1984). This association is important: the perception that computers are to be "machines for males" can have considerable influence on the attitudes and performance of both boys and girls in computer classes. If girls are lacking in interest and motivation and they see boys reacting with confidence and asserting control over the computers, then their participation in computer classes is likely to be further reduced (Equal Opportunites Commission, 1983). Evidence of this was seen in the Queen's Creative Uses project. Boys in a Grade 7 class had complete control over the five computers in their classroom and, as their enthusiasm and confidence increased, that of the girls declined. At the end of the year the girls felt that they were so far behind that they could never catch up. Some commented that they never wanted a computer in their classroom again (Moore, 1984; Carmichael et al., 1986).

The association of computers with the concept of a "male culture" begins at an early age. Boys in a Michigan preschool started a computer club exclusively for males until their teacher

intervened (Kiesler, 1983). Researchers looking at the impact of computers on the social life of two elementary classrooms, noted that computers were the one area where children consistently identified certain of their peers as sources of help. In both classes observed, involving children 8-9 years and 10-11 years, the children identified boys as the experts (Hawkins, 1982).

Surveys of student preferences are less definitive. When questioned, a large proportion of children perceive that boys and girls like computers equally. However, for those students who do express a preference there is a tendency to choose boys as liking computers better. This tendency is more evident among boys than girls, and more evident at higher grades than lower grades (EOC, 1983; Clarke, 1985; Wilder, 1985). However, when the context is changed to examine all-girl schools, the results are different. In a recent study in such schools in Australia, the students perceived girls as liking and being better at computing than the boys (Clarke, 1985). This difference in perceptions between girls in single-sex schools and those in coeducational schools shows the importance of the social context of the school.

Research on gender differences and mathematics has shown that children as young as Grade 1 are socialized to believe that mathematics is a "male" subject and it is suggested that this is one of the reasons girls do not choose mathematics once it becomes an elective course. Girls do not like to compete with boys. If girls consider a subject to be "male" they tend to underestimate their abilities in that subject and avoid it whenever possible (Passmore, 1980).

The attitudes of students towards computers are important because they can affect the students' performance. A study of primary school children in Australia working with Logo, showed there was a marked difference between the boys and girls in factors relating to computer performance. The performance of boys was predominately related to their general school ability, but for girls, performance was more strongly related to their attitudes to computing (Clarke, 1985).

Association of Computers with Mathematics

Interviews with children from eight to twelve years of age indicate that they believe computers are used for mathematics and science tasks. This leads to the belief among children that one must be mathematically inclined to use computers (Hawkins, 1984; EOC, 1983). This places a barrier between girls and computers from an early age. Research shows that girls' interest in mathematics begins to decline in the middle school years (Koehler, 1982; Eddowes, 1983). A study in England of 12- and 13-year-old students in mathematics problem-solving classes showed that, at the end of the year, the test scores for boys had increased and those for girls had dropped (Preece, 1979). The boys felt that math was becoming more challenging and their confidence increased. The girls expressed an air of helplessness, they did not expect to succeed; they felt no one else expected them to either; what was the point of trying? Badger (1984) also notes that, in the early teen years, discrepancies between boys and girls in mathematics arise in the areas of problem-solving and spatial ability, two areas closely

associated with computing. Research already undertaken on gender differences and computer use shows clearly that, by the middle school years, girls in coeducational schools lose interest in computers. In addition, confidence in their abilities to use them diminishes and they withdraw from the subject (Alvarado, 1984; Moore, 1984; Watt, 1984).

At the high school level, there is often a close connection between computers and mathematics because the computers are frequently placed in mathematics departments and the courses taught by mathematics teachers (PEER, 1984; Hawkins, 1984). Furthermore, mathematics courses are often a prerequisite for programming courses. As a result, these courses tend to be reserved for the brightest mathematics students, who are traditionally assumed to be male (Lockheed, 1985; PEER, 1984). Even when mathematics courses are not a prerequisite, students believe that they are necessary to enrol in computer courses. A survey of Grade 10 and 12 students at three surburban American high schools showed that students who were inexperienced with computers tended to overestimate the difficulty of introductory computer coursework. These students were almost twice as likely as experienced students to list advanced mathematics, such as trigonometry and calculus, and science courses, such as physics and chemistry, as essential prerequisites (Cole, 1983). Given that the enrolment trend in high school science and mathematics courses has consistently favoured the boys, it is not surprising to find a similar tradition in the area of computer studies (Fetler, 1985).

Nature of Computer Courses

Most computer courses offered at the high school level are programming courses and most girls do not like to program (PEER, 1984; Sanders, 1984; Hawkins, 1984; Lockheed, 1984). At the elementary level, girls prefer to draw pictures using the Koala Pad or Graphics tablet, while boys prefer to program (Moore, 1984). This is due partly to the association of programming with mathematics, but it is also suggested that the demands of programming, which stress rules and winning are incompatible with socialized female values. This situation further deters the girls. Some researchers also feel that boys are more likely than girls to have the cognitive skills needed for programming (Lockheed, 1985; Mandinach, 1985). Programming is the most cognitively demanding computer environment because it involves diagnosing and devising solutions to problems. Similar cognitive skills can be fostered in certain types of educational and entertainment software. Typical programs are "Rocky's Boots", "Space Invaders" and "Jumpman", which emphasize planning and trouble shooting. Girls spend less time than boys playing computer games and video games. Therefore, they miss the opportunities to develop the skills necessary for the computer learning environment and come to the computer with less relevant experience (Linn, 1983).

Another reason given for the failure of girls to enrol in computer programming courses at the high school is that they do not find these courses relevant to their needs. Studies show that girls are not interested in exploring what the computer can do, and they find no immediate practical uses for programming skills. Girls prefer to to learn applications programs such as word processing, data base use, or graphics programs (Lockheed, 1985). Similarly, research

into the reasons for the low number of girls in advanced mathematics courses shows that girls withdraw from the subject because they do not find it useful. In contrast, some boys take advanced mathematics courses because it is expected of them, or because of the status of such courses with their peers and teachers (Russell, 1984). It appears that boys feel less free to withdraw from certain subjects than do girls.

Different Behaviour Patterns of Boys and Girls

Girls in the middle school years and at high school are very sociable, preferring people to things. At high school, the friendship of another girl or girls may take priority over all other relationships, even family relationships (King, 1986). Girls spend a lot more time interacting with their friends than boys do, and they are much more likely to ask their friends for help and advice. Because computing tends to be a solitary activity, it is less appealing to girls. If a girl chooses to isolate herself in the computer room, she will have more to lose than a boy, since her behaviour may jeopardize both her friendships and social standing (Sanders, 1984). Girls like to work together in groups or in pairs. Cooperation is important to them, and they tend to shy away from competition with their peers.

In contrast, boys are particularly aggressive and competitive in the middle school years (Eddowes, 1983). This was seen in one of the Grade 7 classes in the Queen's Creative Uses Project, both in the way that the boys obtained computer time and also in their work. At the end of the second year of the research project, boys and girls were interviewed separately to discuss their computer use and to give suggestions for its improvement. All the students agreed that boys got the most computer time, but the reasons cited varied. According to the girls, they were pressured by the boys to trade or give up their computer time; the boys insisted that the girls did not want to use the computers. Whatever the reason, if boys saw an unoccupied computer, they took it, sometimes having access to the computer two or three times a day. This classroom had five computers in three different models, and two printers. The boys frequently relegated the girls to the computers without printers, or to the less popular makes of computer (Carmichael et al., 1986). Other studies also report this tendency for the girls and the quieter boys to give in to the pressure exerted by other students on scarce and valuable resources (Eddowes, 1983; Boss, 1982; Whyte, 1984). Researchers studying coeducational comprehensive schools in England frequently noticed that when resources in the science laboratories were limited, especially when some were in better condition than the rest, boys tended to crowd out girls and end up with most of what was available (Whyte, 1984). Girls defer to boys to prevent hostilities and avoid disturbing the classroom activities. If not regulated, the "free" computer time during lunch times and before and after school also tends to be dominated by boys (Sanders, 1984; Schubert, 1984; Sheingold, 1983).

Research in coeducational schools shows that boys demand and receive more of the teacher's attention and of other available resources in the classroom, such as space, books, science equipment, and computers (Sadker, 1985; French, 1984; Whyte, 1984; Fisher, 1984). In computer classes boys are very competitive and aggressive, frequently moving in and taking over the

computers (Moore, 1984; Carmichael et al. , 1986; Fisher ,1984; Boss, 1982). Girls defer to boys to avoid hostility. Consequently, computers become a "male" domain (Lockheed, 1985).

Boys also thrive on the competitive nature of computer programming. The children in a Grade 7 class in the Creative Uses Project were working with the programming language Logo. The teacher presented weekly challenges to motivate the students on the computer; students could also present challenges to their peers. These challenges were designed to encourage the children to think and discover things for themselves. The challenges were optional and students were free to work on other activities of their choice. Boys really enjoyed the challenges ; those who finished them first received a lot of praise and attention from the teacher and from their peers. While the challenges were a great incentive for the boys, the girls lost interest because their efforts were not acknowledged and recognized. One girl commented, "Boys get commended for things that girls can do too, but we complete it half an hour later, and it doesn't matter then". As the boys continued working with the challenges, the gap in programming knowledge between boys and girls became even greater. When they were asked if the boys acted in a similar fashion in other subjects, the girls said that they did in mathematics (Carmichael et al., 1986).

The Social Context of the Classroom

The education system, as one of the major socializing institutions, has an important role in the teaching of cultural values and beliefs to children. Some researchers believe that schools are developing and reinforcing segregation of the sexes, and promoting sex-role stereotypes and discrimination. These actions exaggerate the negative aspects of sex roles in the outside world when, in fact, they should be alleviating them (Delamont, 1980).

Research shows that, from the early grades of elementary school, it is common for classrooms to be highly segregated, both in seating arrangements and for group work (Sadker, 1985). Compared to adults, children in the first grade view more activities as suitable only for one sex (Smithers, 1984). Young boys are much more strongly sex-typed than girls and have very definite ideas on what boys should and should not do. These ideas are transmitted to girls, showing them clearly that certain subjects are not for them. It is suggested that girls' lack of success in mathematics is due to social and cultural factors, rather than to lack of ability. Girls tend to underestimate their performance in general, but particularly in subjects considered to be male activities (Badger, 1984).

Girls in the first three grades of elementary school expected to get lower marks in mathematics than boys, even though their actual marks did not warrant this view. Similarly, girls expected to get higher marks in English (Entwistle, 1983). The notion that boys are good at mathematics and girls at English is obviously so well ingrained that children expect it from the first days of school. This attitude continues through high school. A survey of Grade 8-12 students in British Columbia showed that girls were less positive than boys in their attitude towards computers, science, and mathematics, but more confident than males in their attitude

towards writing stories, essays, and compositions (Collis, 1985). A survey of Ontario high school students showed that males were more likely to take mathematics, chemistry, and physics at the Grade 13 level, while girls were more likely to take languages and biology (King, 1986).

There is evidence that computer access and use in the classroom tends to reinforce sex role behaviour. In a Grade 7 class in the Creative Uses Project, there was little interaction between the boys and the girls. The boys helped each other and shared their discoveries. Half of the children in this class were experienced computer users, having had computers in their classroom in the previous year. The "new boys", however, were soon absorbed into the computer culture and caught up with the rest of the boys. The girls would admire the boys' discoveries but not incorporate them into their programs. The gap between boys and girls widened as the year progressed (Carmichael et al., 1986)

The day-to-day interaction with the teacher has a very important influence on students: it affects the way students feel about themselves as learners in different subjects. Students respond differently in class according to the sex-role expectations exhibited by teacher and society (Becker, 1981; Fennema, 1980). Researchers observing the teacher-student interactions in a second grade class found that teachers made more academic contacts with girls during reading classes, and with boys during mathematics classes. In addition, teachers spent relatively more cognitive time with the girls in reading and with the boys in mathematics (Leinhardt, 1979). This indicates clearly that teachers expect girls to be proficient in English, boys in mathematics. Other researchers observed fourth grade mathematics classes for differences in the amount of time teachers gave high, medium, and low academic achievers, or boys or girls, to answer questions. There was no significant difference among the achievement levels, but it was found that teachers gave significantly more time to boys than to girls (Gore, 1983). Similarly, observations made in chemistry, physics, and biology classes at both junior high and high schools in New England showed that boys and girls were treated differently. Girls were shown the answers to problems, while boys were given further instructions or questions to help them solve the problems independently (Allerdice, 1984). Such inequities make girls less confident in themselves and more dependent on teachers.

Because computer studies is a recent addition to the school curriculum, little research has focused on student/teacher interactions. In one study in England, computer classes in the second and third year of high school were observed and the student/teacher interactions noted. The teacher, a male, was consciously trying to avoid any gender bias in his lessons, but clear examples of inequities were noted. In one class the minority of students were boys, but they still accounted for a large proportion of the input of the lesson. In another class in which girls were a minority, the observer abandoned charting the interactions because the girls took no active part in the lesson (Eddowes, 1983). A recent study in Ontario compared the attitudes of elementary school teachers and students towards computers in the classroom; 40% of the teachers were in strong agreement that it is more important for boys to learn about computers than girls (Vermette, 1986). If teachers feel that a subject is more important for one group of students than another, they are more likely to give them additional time and encouragement.

The foregoing observations were made in classes with both male and female teachers. However, it is not necessarily the sex of the teacher that is important: the attitudes and perceptions of teachers can foster and maintain sex-role differences in the classroom. A survey of 60 Ontario high school teachers showed that teachers notice the traditional sex-role differences in their classrooms, and feel that students want to be treated accordingly. By doing so, teachers may be reinforcing traditional sex roles. These teachers, when asked for a preference in teaching boys or girls, tended to say boys (Ricks, 1973). This tendency has also been noted in other more recent research studies. The reasons given were that boys are more outspoken, easier to talk to, and more willing to exchange ideas. The only reason cited for preferring girls was that they were easier to discipline (Stanworth, 1983; Eddowes 1983). Almost three-quarters of the male teachers in the Ontario study thought that women with children should stay at home, and 31% of the female teachers agreed (Ricks, 1973). If teachers hold these traditional views of students, it will affect their student-teacher interactions. Although this research was done over ten years ago, more recent research in Australia suggests that these views may not have changed significantly (Evans, 1982). This research, designed to see if teachers' perceptions of sex roles and sex-appropriate behaviour have changed in recent years, shows that teachers' classroom practices continue to reinforce conventional sexual stereoypes. Although the teachers considered themselves to be modern and liberal, their behaviour did not reflect this. They saw the female student's role as primarily concerned with motherhood and possibly a second income, but not in terms of a career. Both male and female teachers (especially the older ones) held conventional attitudes towards the future occupations of students of both sexes (Evans, 1982).

It is often suggested that female teachers, particularly in the areas of mathematics, science, and technology act as good role models for female students. Research has shown that the teachers who use computers most are female. A national survey of American schools shows that two-thirds of the major computer-using teachers in elementary schools are female; at the high school level, the proportion of teachers in this role is also relatively high considering the number of women high school teachers (Becker, 1985). However, evidence from the Computer Equity Training Project suggests that the influence of female teachers as role models for girls is slight. Children at one of the pilot schools were asked how they felt about having female computer teachers. Only 11% of the girls agreed that seeing a female teacher use computers encouraged their computer use; 7% of the girls agreed that seeing male teachers use computers had the same effect. Thus, having a female teacher appears to give a marginal advantage to girls (Sanders, 1985).

At the elementary level, however, there appear to be other factors that are more important than the sex of the teacher in encouraging computer use by girls. At the end of the term girls in the study just cited were asked about the extent to which a variety of factors had encouraged their use of computers. At the three schools, only 32%, 22%, and 19% of the girls said that seeing female teachers use computers had encouraged them to use computers. Other factors such as "girls only" Logo and computer classes had greater impact (Sanders, 1985). It is important to have well-trained, competent teachers. Girls, in particular, feel insecure if they lack confidence in their teacher's knowledge of the subject (Eddowes, 1983).

The presence of a female high school principal may act as a role model for girls, but has little influence on boys. A comparison was made of the attitudes and sex stereotyping of students at high schools with female principals and high schools with male principals. The research sought to discover if the presence of a woman in a leadership role was related to a greater acceptance of women's capabilities. The results showed that significantly more boys than girls believed that women lack the characteristics necessary for leadership, regardless of the sex of the principal (Sampson, 1979).

Research in England and Australia shows that girls in single-sex schools tend to be more successful than girls in coeducational schools (Smithers, 1982; Clark, 1985). In England, fewer girls study science at coeducational schools than at single-sex schools. It appears that, at coeducational schools, science becomes sex-typed and dominated by the boys. Girls with superior ability do not appear to be influenced by the sex-typing, for they make similar choices at both schools. Less able girls show a tendency to study the arts at coeducational schools than at single-sex schools. Lower-ability girls from working class homes are less likely to take the physical sciences at either type of school than lower-ability boys from similar families (Smithers, 1982). In single-sex schools, girls do not have to compete with boys: all educational pursuits are being provided solely for them. In addition, the curriculum may be more relevant to girls and there are many female role models. In contrast, at coeducational schools the gender-based power structures evident in the wider social context are present, characterized by male dominance. The boys are encouraged to be aggressive, competitive, and independent, and the girls to take second place.

Software

Many young people get their first exposure to computers outside of school at video arcades, but few girls go to these arcades. Those who do, watch rather than play the games (Kolata, 1984). In addition, boys are more likely to play computer games at home (Miura, 1983; Sanders, 1984). Thus, many more boys than girls are getting intuitive knowledge and experience through computer games, advantages which they bring to classroom computer environments.

One of the reasons cited for girls' lack of interest in computer games is the scarcity of appealing software (Beyers, 1984; Bumgarner, 1984). Most of the early computer software was written for males by males, with themes that appeal to males. Many have militaristic titles like "Submarine Attack" and "Space Wars" (Miura and Hess, 1983). Much of the software concentrates on competition, aggressiveness, and rapid, violent action. The symbols and images often have a strong male bias: rockets blasting off when a correct answer is given, or cars racing across the screen displaying scores. Numerous educational games were also written with the male student in mind. "Master Type", a popular educational game, is an arcade-style game in which students practice typing skills by blasting alien letters out of the sky with a laser gun. "Alien Addition" and "Duelling Digits" are also arcade-style action games to motivate children to practice basic skills in mathematics, reading, and spelling (Maripodi, 1984; Watt, 1984). A study of sex differences in the interests of elementary school students in various games noted

that boys prefer scoring, competition, and bombing, while girls like games with a fantasy element (Kreinberg, 1983). When 150 junior high school students examined a random sample of 75 software titles (games and education programs) for sexual stereotyping, only 5% were judged to be primarily of interest to females (Miura and Hess, 1983). When a small group of adults were asked to rate the same 75 titles, the results were almost identical. Much of this male-oriented software is widely used at home and in some schools.

More recently, software developers, particularly those associated with educational software, have produced materials with much wider appeal. All software developed for the Ontario Ministry of Education is evaluated for sex-equity/gender issues. Software developers are provided with guidelines for avoiding bias, and they are given a questionnaire to be used during evaluation and field testing (Wolfe, see Appendix B).

Influence of Parents

Research suggests that parents encourage their sons to become involved with computers to a greater extent than their daughters. In a study of enrolment in computer camps in the United States, it was seen that the male-female ratio was much greater at expensive camps than in low-cost programs (Miura and Hess, 1983). Parents seem more willing to invest in this type of training for their sons than for their daughters, possibly because they feel it is more important for boys' career plans. In the Creative Uses Project, one teacher noted that at a parent/teacher meeting he discovered that the majority of boys in his class were getting parental support in their computer work (Moore, 1984). This corroborates what the children had indicated on the questionnaires given to them at the beginning of each year. At that time, children were asked if their parents had encouraged them to use computers, 82% of the boys said "yes" compared to only 29% of the girls. After a year of computer use, however, 100% of the boys and 70% of the girls reported that their parents encouraged them in their computer work.

Parents more often expect their sons to be interested in computers than their daughters, and are more likely to buy them computers and video games. Fathers are more likely to work with their sons at the computer at home, and to encourage them to read computer magazines (Sanders, 1984; Moore, 1984).

Parental attitudes towards their children frequently follow the traditional sex-role stereotypes. This was seen in a study of 98 family units, with both sons and daughters. While playing a simulation game, "Career Planning", parents had to make decisions regarding career choices for their children and the allocation of limited family funds for education and job training. It was found that boys were given advantages over girls 80% of the time (Gripsover, 1984).

Influence of Role Models

From an early age boys and girls play very different roles. Boys are encouraged to actively explore and manipulate the environment, while girls become increasingly more skilled in verbal

and social functions. The world of toys and games offers girls a far more restricted range of roles than it does boys. In addition, the roles offered to girls are usually passive, home-centred non-scientific, and non-technical (Best, 1983; Delamont, 1980; Turkle, 1984). Boys acquire different skills from their play activities than girls, giving them advantages when they enter computer-learning environments.

Traditional role perceptions were noted in research conducted by Nancy Kreinberg and Elizabeth Stage at the Lawrence Hall of Science, University of California, Berkeley. In this study, 445 girls and 425 boys from Grades 4-12 were asked to describe how they would use computers when they were 30 years old. Boys typically answered that they would use them for finances, data processing, and games. Girls thought they would use them to do the housework (Kreinberg, 1983). A survey of 300 teenage girls in London, Ontario also shows that, despite exposure to feminist ideas, young women still have very traditonal ideas about what the future holds for them. Most of these young women, in stating their career aspirations, overlooked the new technology and computer fields in favour of traditional professions, such as nursing, teaching, clerical, and secretarial work (The Toronto Star, January 18, 1986).

The advertising industry is one of the strongest cultural influences. Advertisements for home computers and computer software frequently feature pictures of men or boys. A study of the illustrations in articles and advertisements in popular computer magazines showed many stereotypical portrayals. Men were shown in the illustrations almost twice as often as women. When women were featured, they were frequently shown as clerical workers and sex objects while men were shown as managers, experts, and repair technicians. In pictures depicting both men and women, the men were most often shown in the position of authority. Only women were shown rejecting the computer (Ware and Stuck, 1985). Such bias in advertising reinforces the idea that computers are not for girls.

IV. TEACHING STRATEGIES SUGGESTED IN THE LITERATURE

The key to closing the gender gap in the use of computers is in recognizing its existence. That recognition must begin with those at the top of the school system; namely, school boards and superintendents (Sanders, 1985). Policies can then be set to promote equitable access and use in schools. These must be started in the elementary school. In order to encourage girls and young women to become interested in computers and proficient with them, it is important to interest females in the technology at an early age. They must also be allowed continuous opportunities to increase their mastery of computers throughout the elementary and high school years (Kreinberg and Stage, 1983). There are many programs designed to make educators and parents aware of the problem and to suggest strategies to overcome the inequities. These include EQUALS, PEER (Project on Equal Education Rights), Computer Equity Training Project (Women's Action Alliance), and IDEAS for Equitable Computer Learning (American Institutes for Research) in the United States. The Equal Opportunities Commission (EOC) and Girls In Science and Technology (GIST), in England, and the Victorian Institute of Secondary Education in Australia are other examples. Such programs as these have produced several useful strategies for increasing female involvement with computer technology.

Removing the Image of the Computer Room as "Male Turf"

The image of the computer room or computer area in many elementary schools as "male turf" must be changed. It is important that elementary school teachers ensure that boys and girls get equal opportunities to use computers before computer studies become an optional high school subject. Once girls perceive that boys are well ahead of them in computer ability, they may give up (Moore, 1984). Strategies for dealing with this problem include:

- reserving the computer room for girls on certain days; When the girls in the Creative Uses Project were asked what they would like to change in their computer program, they suggested separate computer days for girls and boys (Carmichael, 1986). This enables the girls to work together and removes the competition with boys for the computers. All the schools in the Computer Equity Training Project set up "girls only" and "boys only" computer sessions after school, and all reported increased attendance by girls (Sanders, 1985).

- encouraging groups of girls, particularly groups of friends, to use the computers (Sanders, 1985); at one of the Computer Equity Training Project's pilot schools, the absence of friends in the course was found to be the most prominent factor discouraging computer use among girls. At another school, when asked what had changed their computer use, 50% of the girls ranked "Seeing your friends use computers" as the most important factor (Sanders, 1985).

- making the room attractive to the girls; Girls like to communicate with each other while working. It is an added encouragement if the computers are grouped together in computer classes rather than being placed in rows, and the girls are allowed to work in pairs or groups (Sanders, 1984).

- starting computers in Kindergarten before the sex-typing of school courses begins; Early exposure to computers gives girls opportunities to see the computer as a natural part of the environment (Beyers, 1984).

- having well-trained female teachers and counsellors as role models, particularly in the intermediate and high school grades where many courses become optional and career decisions are made (Kreinberg, 1983; EOC, 1983).

Using Computers Across the Curriculum

Computers are a relatively new addition to the education system particularly at the elementary level. Often they have been placed in classrooms without too much thought or planning (Alvarado, 1984). Yet the manner in which computers are integrated into the classroom is important because it can influence students' self-perceptions, motivations, and behaviours regarding their use (Gripsover, 1984). Typically, at the elementary level, they have been an

addition to the classroom rather than an integral part of the curriculum. The emphasis has been on computer literacy and programming, areas which many children associate with mathematics and science. In order to modify this connection the following strategies are suggested:

- Whenever possible, every effort should be made to use computers in classes which are viewed as non-gender-specific. These might include simulation programs in social studies, graphics packages in art, music packages in music (Maripodi, 1984; EOC, 1983).

- Young children, rather than learning about computers, should learn with computers, using them as tools across the curriculum for word processing, data entry, and graphics. The computer may then be accepted by all students as a normal classroom activity (Maripodi, 1984; Lockheed, 1984).

- The association of computers with mathematics at the high school level can be eliminated by moving the computer laboratories from the mathematics or science departments and placing them in other areas of the school (Alvarado, 1984; Schubert, 1984).

- Computer science courses at the high school level should be introduced by stressing computer applications programs, such as word processing, personal filing systems, and spread sheets. Girls find these of greater immediate practical use than computer programming (Lockheed, 1985; Kruger, 1985). Once they are comfortable with these uses of the computer, more girls will be encouraged to take computer programming courses.

- If computers are being used in a variety of curriculum areas, they may be used in mathematics to improve the attitudes of girls towards that subject. Preliminary research at different age levels suggests girls' attitudes towards mathematics and their mathematical skills may be enhanced by working with Logo. Forty-three girls took part in a pilot study in Australia to see if working in a Logo microworld would result in an improved attitude toward mathematics and an improvement in their general ability, by developing logical thinking and reasoning skills. The students were in years 1, 3, and 5. Results showed that the Logo experience had a positive effect on their general ability and on their expresssed interest in learning about mathematics (Clarke, 1985). Similarly, a study in Edinburgh suggests that working with Logo can improve mathematical skills. This study involved about eighty students aged 12-13 years in each of a control and experimental group. Analysis of pre- and post-tests showed that girls who worked with Logo showed greater improvement than the girls in the control group who did not. (Howe, 1985).

- Teachers should encourage students to use computers for a school newspaper, for school organizations and clubs, and for maintaining files for school teams (Lockheed, 1984).

- Teachers should guard against the tendency to encourage boys to use the computer for higher level activities such as programming, while girls are relegated to "drill and practice" or graphics tablets (Gilliand, 1984). This is particularly important in class-

rooms where the computer is not considered part of the regular curriculum. In the Creative Uses Project it was noticed that given the choice, boys would write programs and girls would draw pictures (Carmichael et al., 1986). This resulted in a widening of the knowledge gap between boys and girls, and a loss of confidence in using computers on the part of girls.

Reorganizing Computer Programming Courses

Research has shown that while boys prefer to use computer programming languages and to play computer games, girls prefer to use the computer for applications programs such as word processing and graphics. Many people believe that learning a programming language is important because it gives the students control over the computer and a clear understanding of its limitations (Fisher, 1984). Wilder (1985) noted that learning a computer programming language increased the females, sense of computer competence. The Ontario Ministry of Education stresses the creative use of computers, suggesting that the programming language Logo be used, particularly in the elementary schools. Although girls prefer Logo to other computer languages, they tend to need more encouragement than boys (Alvarado 1984; Fisher, 1984). Suggestions for encouraging girls to take computer programming courses include:

- making computer programming courses at the middle school or early high school years compulsory; This would give all students a chance to learn a computer language. Research has shown that girls often perceive computer programming to be more difficult than it really is (Cole, 1983). This perception, coupled with pressure from their peers, often deters girls from enrolling in computer programming courses. If it were compulsory, they would not have this option.

- using Logo, not Basic, as the programming language; It is suggested that girls prefer Logo to Basic because of the former's graphic capabilities (Alvarado, 1984; Fisher, 1984; Maripodi, 1984; Eddowes, 1983). In a school district in California, 50% of the students taking computer programming courses involving Logo were girls, compared to 30% where Basic was used (Fisher, 1984).

- holding separate computer programming courses for girls, particularly introductory classes in the elementary grades; This is suggested for four reasons: (i) girls and boys are brought up differently. From birth they have different play activities and different toys. Consequently, girls have not acquired the same knowledge and skills as boys. If girls are taught separately, these differences can be diminished; (ii) girls have less experience with computers so they may need more instruction about how to take advantage of computer learning environments than the boys. Similarly, girls may benefit from guided explorations which encourage them to experiment and go beyond the information given. Researchers observing children playing two games, "Wumpus" and "Rocky's Boots", noted that boys were more likely to experiment and go beyond the information given; girls were much more likely to ask for help (Linn, 1983). Similar observations were noted when elementary

children were working with Logo (Moore, 1984; Carmichael et al., 1986). In England, girls reported that they felt they needed more time to understand the different concepts than the majority of the boys in their computer classes (Eddowes, 1983); (iii) if girls have separate classes they have time to practise computer games. It is often reported that girls do not do as well as boys at computer games because their spatial abilities inferior to boys'. However, research has shown that, given time to practise, the girls can score as well as the boys; (iv) since girls tend to fear failure, it is essential to allow them to progress at their own speed and not place them in undue competition with their peers (Eddowes, 1983). If girls feel competent using computers they may enrol in more advanced computer courses at high school.

- having separate computer classes for girls at the high school level; It is suggested that girls work better when working together than when working with a group of boys. It has been shown that more young women enrol in female-only science and mathematics courses at college and high school (Menzies, 1984). The North York Board of Education is currently holding separate mathematics classes for boys and girls in its high schools. This project started in 1984 with Grade 10 students and will continue for at least four years. Since the main drop-out of girls from mathematics courses occurs in Grade 12, this strategy might be an effective preventive measure.

Becoming Aware of Different Behaviour Patterns in the Classroom

There is little interaction between the boys and girls in typical elementary classrooms. The boys tend to be aggressive and competitive and can intimidate the girls, particularly in subjects considered to be "male". To counteract this, teachers should:

- encourage cooperation rather than competition between the children in the classroom; If challenges are to be presented, have some that are "open-ended". When discoveries are made, have sharing sessions with all the students, so that none of the students feel left out. Girls prefer the cooperative way of learning (Carmichael et al., 1986; Kolata, 1984). Since girls tend to fear failure, it is essential to allow them to progress at their own speed and not place them in undue competition with their peers (Eddowes, 1983).

- have class discussions on equity issues (American Institutes for Research (AIR), 1985).

- make a schedule giving everyone equal access to the computer (where computers are being used in a regular classroom rather than in a computer laboratory), and ensure that it is followed; It is important to make the students aware of the need for everyone to have equal time to use the computers. Equal access does not necessarily mean equal use. Boys, particularly in the middle school years can be very aggressive, intimidating the girls in order to have extra computer time. The girls give in to the boys to avoid hostility and to prevent causing a disturbance in the classroom (Carmichael et al., 1986; Moore, 1984).

- make sure there is equal time available for girls and boys during lunch times and before and after school; If necessary hold separate days for boys and girls (AIR, 1985; Carmichael et al., 1986; PEER, 1984).

Making Teachers Aware of the Social Context of the Classroom

The positive attitudes and skills of teachers, counsellors, and administrators can have a beneficial effect on females (Gilliand, 1984). If boys and girls are to have equal opportunities at school, teachers must:

- be aware of sex biases in young children; At least two types of gender bias are found in educational and social settings during early childhood: (i) the belief that some activities are suitable for girls and others suitable only for boys and (ii) the belief that certain aptitudes and behaviours are sex-linked (AIR, 1985). It is important that the teachers in the early grades provide the children with experiences that encourage them to develop attitudes, abilities, and interests that are free from gender bias.

- be aware of the ways in which boys and girls are often treated differently in the classroom; Most teachers are surprised to learn that male students receive more attention than female students. Once alerted, however, they want to change their teaching so that it becomes more equitable (Sadker, 1985).

- make sure that girls are chosen as frequently as boys to help with the computers, either for demonstrating new software, acting as peer teachers to other students, or doing extra work for the teacher.

- be aware of their own sex-role stereotyping (Maripodi, 1984); All boys are not more able with computers than all girls.

Assessing Software Packages for Sexism

If young girls are to be encouraged to use computers, software must be appealing to them. Educators should:

- review all software packages for any signs of sexism; It is important to be aware of the types of reinforcers used in educational software. Packages that use "touchdowns", "home runs" and other traditionally gender-related rewards, will appeal more to boys than to girls.

- be aware of the software that reinforces gender bias; For example, "Spelldiver", a spelling and word recognition game, suggests that girls like spelling (Brady, 1985).

- use sex-neutral software by taking programs that are open-ended, which students can use in different ways to accomplish different individual goals; Such software appeals equally to

boys and girls because it can be adapted to their different interests. Software such as "Bank Street Music Writer", which enables students to compose a musical piece and "Survey Taker", which students can use to create and tabulate their own surveys, fall into this category (Brady, 1985).

- look for software that expands girls' interest in non-traditional pursuits; One such program, "Voyage of Mimi", combines videotapes, software, and student and teacher booklets in a manner that entices girls into the areas of mathematics and science activities, by using female interests. Research shows that this software appeals to both boys and girls (Brady, 1985; Hawkins, 1984)

Making Parents Aware of the Problem

Parental influence is an important factor in students' subject and career choices, so it is important that girls have the support and encouragement of their parents if their schooling experience and career options are to be improved. In a London survey of 300 teenage girls, those who excelled in sports or who were in the top third of their class, credited their success to the encouragement they received from others, especially their parents (The Toronto Star, January 18, 1986). School guidance counsellors and teachers can use parent-teacher nights to:

- make parents aware that it is as important for their daughters to take a computer class at school as it is for their sons, if girls are to have equal opportunity to enter high-growth and well-paying computer occupations; Teachers should inform parents and students of the use of computers in the various occupations, the salary ranges of workers in the computer industry, and the opportunities for women in these fields.

- inform parents that if there is a computer at home, they should encourage their daughters to use it, and not let their sons monopolize the computer; In addition they should make sure that there is software that will interest their daughters.

- encourage parents to enrol their daughters in computer courses outside of school, particularly in "girls only" courses if they are available.

- encourage mothers to act as role models for their daughters by using computers themselves; In most families the male members of the family are the main users of home computers (Sanders, 1985).

- hold computer workshops for women teachers and invite mothers to attend these workshops (Davidson, 1984).

Making Students Aware of Sex-Role Stereotyping

Boys as well as girls need to be aware of the influence of sex-role stereotyping on their lives. Teachers and guidance counsellors can help their students by:

- promoting class discussions to help students become aware of the bias in computer advertising; The could have students examine software catalogues, T.V. advertising, and computer magazines to tally the number of times males and females appear.

- surrounding students with examples of how computers are used in the workplace; Books, periodicals, films, and bulletin displays can be used to demonstrate how computers are used in education, the health professions, science, industry, and government. It is helpful to feature both males and females in active roles with the computer (Maripodi, 1984).

- talking to girls and encouraging them to take courses needed for non-traditional jobs; Girls are being pressured into thinking about careers but are not receiving the necessary guidance. Consequently, many girls are not taking the courses that are necessary for the careers they choose (King, 1986). The London study also reported that although most of the girls said they wanted to attend college or university, this expectation diminished with every passing year. Many of them expected to be doing something other than what they really wanted to do. Thirty-seven percent of the 13-year-old girls and 43% of the 18-year-olds expressed this hopelessness about directing their future (The Toronto Star, January 18, 1986).

Holding Workshops for Teachers

Few teacher training courses include a comprehensive study of sex differences in education or a discussion of sex-role stereotyping. Many teachers are not aware of the problems of sex-role stereotyping, and are frequently surprised when they realize that they treat boys and girls differently (Sadker, 1985; Whyte, 1984). Workshops and in-service teacher training can have a very positive effect on teachers. Examples of such workshops are:

- GIST (Girls in Science and Technology) Workshops; The aims of the GIST program in England were to make teachers aware of the sex differences in classroom interactions and to learn how these differences affect the learning of boys and girls. Classrooms were observed and the student-teacher interactions noted. Most of the teachers were very surprised at the amount of attention they gave to the boys. Workshops were held to stimulate discussions to help teachers recognize sex-role stereotyping, to discuss the problems of getting girls interested in science and technology, and to develop their own ideas for intervention strategies (Whyte, 1984; Smail, 1982).

- EQUALS, a teacher education program at the Lawrence Hall of Science; This 30-hour program seeks to promote the participation of girls and young women in computer science. It is an in-service program with three main aims; (i) increasing the awareness of the issue of computer education for females; (ii) providing instructional material that encourages confidence and competence in using computers and; (iii) motivating students to pursue computer-related occupations through the use of role models (Kreinberg, 1983). EQUALS teachers learn to ensure that all students get hands-on experience with problem-solving and word-processing programs, experience that gives them power over the machines (Gilliand, 1984).

- IDEAS for Equitable Computer Learning, produced by the American Institutes for Research; This consists of a set of classroom strategies to help educators improve computer learning for all students. It is the result of a research study that identified situations and behaviours that impede computer access and use. In addition to the set of practical strategies, it includes a computer survey for students and a self-assessment checklist of behaviours for the teacher. AIR has also developed a training program called SISCOM. This is an out-of-school computer learning program aimed at correcting the imbalance between male and female usage of computers. It also makes girls aware of computer career opportunities (AIR, 1985).

- Women and Computer Workshops, organised by the Victorian Institute of Secondary Education in Australia; These workshops were organized for the professional development of teachers in all curriculum areas to enable them to develop skills in the use of computers, to understand their impact on society, and to become familiar with their application across the curriculum. Parents were also invited to take part in the workshops (Davidson, 1984).

- workshops focusing on equity in classroom interactions; These can have a positive affect on all classroom interactions. In fact, research has shown that such training of 60 teachers virtually eliminated bias, increased the number of intellectual interactions, and increased the precision of the teacher interactions (Sadker, 1985).

Conclusion

The foregoing review of the literature shows that there are imbalances between the boys and girls in the use of computers. It is important to stress that not all boys are computer "hackers" and not all girls avoid computers. In fact, girls who take computer courses do as well as boys (Kolata, 1984). However, a very large number of girls who are capable of taking computer courses, are for a variety of reasons, choosing to take other courses. In so doing they are limiting their development and restricting their job opportunities.

Following the implementation of strategies aimed at achieving equity in education, it is important to assess the impact of changes. Such an evaluation should include assessment of:

- the effects of early computer education (e.g., from Kindergarten onwards)
- the impact of single-sex computer classes
- the impact of compulsory computer classes
- the effectiveness of in-service programs for teachers.

As the need for women in technological fields expands, the image of computing as a male-dominated field must change. This change must start in the schools. Teachers, counsellors, and administrators must encourage girls to participate in computer courses. Their positive attitudes and skills can help overcome the negative social conditioning of females. Thus, educational opportunities for all students can be improved.

V. SUGGESTED SURVEYS: ONTARIO

Research already completed, or in progress, clearly indicates that boys have an advantage over girls because of their greater access to computers, both at home and at school throughout the elementary and high school years. The reasons for these differences have been identified by several researchers looking specifically at the use of computers in education. These findings are similar to those of researchers examining the reasons for girls' avoidance of mathematics and science for which there is already a large body of research.

Examination of this paper's Annotated Bibliography shows that much of the research on gender issues in the educational use of computers has been conducted outside Canada. More recently, Canadian researchers have become interested in this topic. In this paper's Current Research Inventory, 16 of 25 research projects identified are Canadian. However, all but one (King and Kass) are either small scale projects or projects in which sex will be looked at as only one of a number of variables. It is clear, therefore, that a major research question to be dealt with is: What is the situation in Ontario in terms of gender issues in the use of computers?

Surveys At the Elementary Level

It is difficult to obtain information on computer use by boys and girls at the elementary school level because computer studies is not a separate subject. Computers are used in many different ways, or not at all, according to the wishes of the teachers and the availability of computers. Teachers who use computers in their classroom are frequently unaware of any gender bias in their use (Carmicheal et al., 1986; Moore, 1985; Sanders, 1985). A survey of Ontario elementary schools would provide useful information on the following questions:

- How many computers are there in each school?
- Are these computers in a computer laboratory/resource centre, or in individual classrooms?
- What grades are using the computers?
- Are the computers used across the curriculum, for drill and practice, computer-aided instruction, enrichment, and/or as a reward for finishing work?

- Are all students assigned equal time on the computer, or is the use voluntary?
- Are the computers used outside the regular classroom times? If so, who uses them?
- Is there a school computer club? What is the gender mix?
- Are the teachers who use the computers male or female?
- Which students have a computer available to them at home?

Such a survey would provide some indication as to gender equity in elementary schools. It would also provide information on other important equity issues such as social and economic issues, by providing information on the number of computers in inner city, surburban and rural schools.

Surveys at the High School Level

It would be useful to examine the enrolment of boys and girls in computer classes in Ontario high schools. In his study of over 44,000 Ontario high school students, Dr. Alan King of Queen's University points out that girls are out-performing boys in most subject areas (King, 1986). Other researchers have indicated that girls who take computer courses and higher level mathematics and science courses perform as well as boys.

Information on enrolment patterns could be obtained through a province-wide survey of the enrolment of males and females in the various high school computer courses. Some school boards already have this information available. For example, Hamilton Board of Education has been collecting such data since 1983. The Ontario Ministry of Education Principals' Reports list the enrolment by sex in all the courses offered at high schools within each board. This information would provide answers to the following questions:

- Do a higher proportion of boys than girls enrol in computer courses at high school?
- Does the enrolment pattern differ with the different courses offered (e.g., computer studies, computer science, computer technology, data processing)?
- Does the enrolment of boys and girls vary according to grade level?
- Does the enrolment pattern differ according to the degree of difficulty of the course for advanced level, general level or basic level?

Such a survey would identify those schools in the province that have a higher-than-average percentage of girls enrolled in their computer courses. Even schools within a board may vary widely. For example, in one board, in September 1985, 29% of all the students enrolled in Grade 12 advanced level computer studies courses were female. However, there were wide differences among the high schools within the board. At one school, 41% of the students taking this Grade 12 computer studies course were female, compared to only 17% at another school. The schools with a high proportion of females in their computer courses could be studied more closely to identify the reasons for the greater participation by girls.

Examination of the situation in Ontario in terms of gender issues in the use of computers could lead to positive change at both the elementary and secondary school levels.

APPENDIX A: ANNOTATED BIBLIOGRAPHY

CONTENTS

Section	Page
PREFACE	24
I. COMPUTERS	25
II. MATHEMATICS AND SCIENCE	45
III. SEX ROLES	55

PREFACE

The use of computers in education is a relatively new phenomenon, but already differences in access to and use of computers by girls and boys are evident. Although there are few differences observed during the pre-school and early elementary years, by the middle school years boys are the dominant users of computers. This has wide-ranging implications for the future education and job prospects of girls and young women.

There are several reasons for this predominance of males in the area of computing. Some are unique to computing, such as the male bias of much current software, while others are associated with more basic differences, similar to those found in other areas of the curriculum, notably science and mathematics. However, research has shown that it is not the subject area or technology alone that produces these apparent differences, but that societal stereotypes also affect classroom behaviour.

This Annotated Bibliography is divided into three sections to reflect these findings. First, it presents literature on gender issues in education which relate specifically to computers. This includes material which outlines the problem, discusses reasons for these problems and gives suggestions for intervention. It reports on research that has been undertaken in Canada, the United States, the United Kingdom and Australia.

Second, it deals with the relevant literature in mathematics and science. Much research has been done over the years on the extent of and reasons for gender differences in these two subject areas. The materials selected for inclusion have findings similar to those now being discovered in relation to computers in education.

Literature relating to cultural factors and sex-role stereotyping is presented in the third section of the Annotated Bibliography. Many researchers have examined social interactions that occur in the classroom, and in the school as a whole. Results show that schools reinforce both segregation by sex and gender bias.

I. COMPUTERS

Alper, Lynne and Holmberg, Meg. "Girls and Computers". In Parents, Kids and Computers: Learning Adventures Beyond the Classroom, pp. 73-80. Berkeley: Sybex, 1984.

The influence of software developers, parents, teachers, and peers, and the general cultural assumptions about how men and women should relate to the technology, are all important in the child's use of computers. Parents who want to encourage their daughters to become involved in computers should: (i) encourage and spend time with them at the computer; (ii) encourage them to enrol in computer classes; (iii) look for classes specifically for girls; (iv) find software that appeals to girls; (v) ensure that mothers get involved as role models.

Alvarado, Anthony J. "Computer Education for All Students". Computing Teacher 11 (April 1984), pp. 14-15.

Throughout the United States, the tragic consequences of the "first purchase, then plan" philosophy with regard to computers has resulted in the widening of the equity gap. Gaps in gender, economics and intellectual pursuits are discussed. A study of students in New York City shows that most boys and girls use computers equally well in the early grades. However, in the middle school years the female students show less interest in computing and tend to avoid elective classes in computing and higher level mathematics. As a result, females leave school with limited career opportunities. The ways in which the New York City Public Schools are dealing with this problem are discussed.

American Institute for Research (AIR), IDEAS for Equitable Computer Learning. Palo Alto, California: American Institute for Research, 1985

IDEAS is a set of classroom strategies that help educators reduce obstacles to computer learning. It was developed by the Center for Educational Equity at the American Institute for Research based on the research findings of a 14 month study looking at incidents in computer learning environments that impede computer access and use for all students. IDEAS strives to help classroom instructors improve computer learning opportunities for all students. It informs educators about situations and behaviours that interfere with computer learning and suggests practical strategies for counteracting these influences.

_____ , "Early Childhood Computer Readiness". In IDEAS for Equitable Computer Learning. Palo Alto, California: American Institute for Research, 1985.

By the time girls reach upper primary and junior high school grades, many are averse to mathematics, science and computers. This aversion is rooted in social attitudes about gender roles and sex-linked aptitudes. These attitudes reflect stereotypical beliefs

about the different abilities and interests of boys and girls beliefs that are instilled in children, often unintentionally, from a very early age. These include: (i) the belief that some activities are suitable only for boys and others suitable only for girls; (ii) the belief that certain aptitudes and personality traits are sex-linked, for example the notion that boys are naturally strong and athletic while girls are gentle and helpful; (iii) the belief that males are naturally mathematical and scientific while females are verbal and intuitive. This paper suggests activities to counteract gender bias and stereotypical beliefs.

Anderson Ronald E.; Welch Wayne W.; and Harris Linda J. "Computer Inequities in Opportunities for Computer Literacy". University of Minnesota Report, 1983 (page numbers not given).

This article on "computer inequities" is based on several questions included in the 1981-1982 U.S. National Assessment of Sciences. A national random sample of 18,000 students aged 9, 13, and 17 were involved in this testing. Results showed that, although opportunities for computer learning in school are increasing, inequities continue. Low-income female and rural students are especially disadvantaged in receiving computer experience and computer literacy in school. Computer programming enrolment remains primarily limited to males attending computer-rich schools in large cities.

Becker, Henry Jay. "Men and Women as Computer-Using Teachers". Sex Roles 13 (November 1985), pp. 137-148.

A study of 2,265 elementary and secondary schools in the U.S. shows that women constitute 70% of the "primary" computer-using teachers (PCUTs) in elementary schools and 44% of the PCUTs in secondary schools. In elementary schools where the PCUT was a woman, the computer was used more for programming instruction and less as a drill and practice tool than in the schools where a man was the PCUT. Women PCUTs used the microcomputers for more hours a day than their male counterparts and were more likely to expand computer use in the school by interesting other teachers in using computers. At the secondary level, however, men PCUTs were more involved with computers and their schools' use of computers was substantially more intensive than in schools where women were the PCUTs.

Beyers, Charlotte. "Bridging the Gender Gap". Family Computing 2 (August 1984), pp. 38-42.

Although there is little difference in achievement between boys and girls who take required computer courses, far more boys than girls take it as an elective course. In 1982 a U.S. nationwide poll of 17-year-olds showed that boys outnumbered girls two to one in high school programming classes. The gap widens as girls leave high school and become college women. The MIT graduate computer science department ratio of men to women is seven to one. Much of the blame for this is put on parents. Suggestions for encouraging more girls to be involved in computers are given. The importance of early exposure to computers is stressed, as it gives girls the opportunity to see the computer as a natural part of the environment.

Boss, Jacqueline A. "Sexism Among the Micros" The Computing Teacher 9 (January 1982), pp. 55-56.

This paper deals with the problems of using a scarce resource with no time for preplanning. With one computer and 530 students it was difficult to recruit new computer users, male or female, and deal with already keen boys. Left to their own inclinations, few girls will get involved with computers. Solutions to the problem include cutting down on the severe competition for computer use by providing more of them; developing programs that will appeal to the more traditional female interests; making teachers sensitive to the problem.

Brady, Holly, and Slesnich, Twila. "Girls Don't Like Fluffware Either". Classroom Computer Learning (April/May 1985), pp. 23-26.

The lack of appealing software is a significant factor in the low level of interest in computers by girls. Software developers are beginning to produce software for girls (e.g., "Jenny of the Prairie", and "Cave Girl Claire" by Rhiannon Software). But programs designed to attract girls actually reinforce existing premises. For example "Spelldiver", another example of software aimed at girls, reinforces the idea that girls are supposed to like spelling. More useful is sex neutral software, tool programmes that provide open-ended frameworks which people can use in individual ways to accomplish individual goals. "Bank Street Music Writer" and "Survey Taker" (Scholastic) are given as examples. A better solution is software that goes beyond stereotypes. The best example of this type of software is "Voyage of Mimi" (Holt, Rinehart, and Winston). This program entices girls into a primarily male domain by blending math and science activities with some unusual and characteristically female interests. Research has shown that this software appeals to girls and boys alike.

Bumgarner, Marlene Ann. "Software for Girls: More than Sugar and Spice". Family Computing 2 (August 1984), pp. 42-46.

Lack of suitable software is often given as one of the reasons for girls' low level of interest in computers. Many arcade-type games do not appeal to girls. Software that does appeal to girls includes adventure games, word puzzle play, building ganes, music, word processing, typing tutorials, and data base systems.

Caissey, Gail, and Howarth, Mary. "Startling Research on Brain Growth". Federation of Women Teachers Associations of Ontario Newsletter 3 (November/December 1984), pp. 2-11.

This article discusses the work of Herman Epstein, an American neurobiologist, and Conrad Toepfer, Professor of Education at the State University of New York, Buffalo. Epstein's research shows that the human brain develops in stages with alternating growth spurts lasting about two years, and plateau periods. The brain growth in females occurs earlier

in the two-year span than in males. This has important implications for school curriculum. Between the ages of 11 and 12 years, girls experience a two- to threefold advantage in brain growth over boys. It is suggested that advanced concepts in mathematics, science, and computer science should be introduced to girls at this stage rather than at the present age of 15-16 years, the period which coincides with rapid brain growth in boys.

Cavin, Claudia S.; Cavin, E.D.; and Lagowski, J.J. "The Effect of Computer-Assisted Instruction in the Attitudes of College Students Towards Computers and Chemistry". Journal of Research in Science Teaching 18 (1981), pp. 329-333.

This study was undertaken to see if the use of CAI programs by students in a chemistry class would change the students' attitudes towards computers or chemistry, and if there would be any sex-related changes in these attitudes. Students were randomly assigned to the experimental group or control group and given tests before and after. The experimental group was given a series of CAI lessons to be completed during the semester, while the control group was assigned written homework at intervals throughout the course. Results showed that attitudes towards computers among female students can be improved by using CAI.

Carmichael, H.; Higginson, W.; Burnett, D.; Moore, B.; and Pollard. P. "Differential Effects on Male and Female Students". In Computers, Children and Classrooms, pp. 106-126. Toronto: Ontario Ministry of Education, 1986.

This two year research study of 13 elementary classrooms in eastern Ontario showed differences in access to, attitudes towards, and use of computers by boys and girls, particularly in the junior and intermediate grades. The differences were most noticeable in the Grade 6/7 classroom where the students had the most computer time. The majority of boys in this class also had computers at home. The boys dominated the computers in this classroom and by the end of the two-year period, the girls' confidence in the use of computers had dropped and many were no longer interested in working with computers. The boys, however, remained very enthusiastic and confident.

Chisholm, Thomas Alexander, and Krishnakumar, Parameswar. "Are Computer Simulations Sexist?". Simulation and Games 12 (1981), pp. 379-92.

This article analyses the response to a questionnaire given to 161 students enrolled in the business program of Slippery Rock State College to determine the existence and extent of differences in the way men and women perceive simulation exercises. All students were, or had been, involved in at least one classroom simulation. Differences were found in male and female perceptions of the usefulness of computer simulations. The article suggests that more research needs to be done in this area.

Clarke, Valerie A. "Computing in a Social Context". Paper presented at the World Conference on Computers in Education, Norfolk, Virginia, July 29-August 2, 1985.

This paper examines gender inequities in education in relation to the social context in which computers are being introduced. Questionnaires given to primary school children from a coeducational school were compared with those given to girls at a single-sex school. Results showed that the sex-typing by girls from the two schools was markedly different. Girls from the coeducational school had similar perceptions to the boys at that school. They perceived that boys would like computers more and be better at computing than girls. In contrast, the girls at the single-sex school perceived girls as both liking computing more and being better at computing than boys. These differences between the two groups of girls were more evident at the higher grade levels than at the lower grade lewels. Furthermore, girls' perceptions and girls' relative liking of computers was shown to relate to their general attitudes to computing and to their computing performance. The implications of these findings are discussed in relation to the social context in which computing is introduced.

_____. "When Attitudes Count". Paper presented at Logo 85, MIT, Boston, July 1985.

The aim of this study was to see if there was any relationship between general ability and attitudes towards computing and the computing performance of primary school children who were learning Logo. Seventy children, from predominantly middle class homes, were involved in the study (42 boys and 30 girls). The results showed that there was a marked difference between boys and girls in factors relating to computing performance. The performance of boys is predominately related to their general school ability, but for girls, performance is more strongly related to their attitudes to computing.

_____. "The Impact of Computers on Abilities and Attitudes: A Pilot Study". Journal of Computers in Mathematics and Science Teaching 5 (Winter 1985-86), pp. 32-34.

It was expected that children who had worked in a Logo turtle graphics microworld would: (i) have an improved attitude towards mathematics because the experience would make abstract mathematical concepts more meaningful and relevant; (ii) show an improvement in general ability because of the development of logical thinking and reasoning skills. The research involved 43 girls from years 1, 3, and 5 of a primary/junior school in Australia. Pre- and post-test measures of attitudes towards mathematics and of general ability were compared and provided support for these expectations.

Cole, Dennis D., and Hannefin, Michael J. "An Analysis of Why Students Select Introductory High School Computer Coursework". Educational Technology 23 (April 1983), pp. 26-29.

This study questioned 121 Grade 10-12 students from three middle-class, suburban high schools. Of these students, 52 had enrolled in introductory computer courses, and 69 had never enrolled in any computer courses. It was found that inexperienced students tended

to overestimate the difficulty of introductory computer coursework listing advanced mathematics (e.g., trigonometry and calculus) and science (chemistry and physics) courses as essential prerequisites more than twice as often as experienced students. Perceptions of career usefulness and parental attitudes towards computers were not found to affect elective participation. Several differences between the responses and achievement patterns of male and female students were also found. Females scored consistently lower on standardized math and science achievement tests. In addition, they perceived their mathematics competency to learn computer skills significantly lower than males.

Collis, B.A. "The Development of an Instrument to Measure Attitudes of Secondary School Males and Females Towards Computers". Doctoral dissertation, University of Victoria, Victoria, B.C., 1984.

A total of 3,000 students in Grades 8 and 12 took part in various stages of the development and use of a measuring instrument to assess sex differences in secondary school students' attitudes towards computers. Significant differences were found, with females being consistently less positive about computers than males, and more likely than males to view computer use and users in stereotypical ways. These negative attitudes were already developed in Grade 8 females. The study also examined various correlates of the computer-related attitudes and studied the effect of participation in school computer literacy classes on students' attitudes.

_____. "Sex Differences in Secondary School Students' Attitudes Toward Computers". The Computing Teacher 12 (April 1985), pp. 33-36.

An instrument for measuring attitudes was developed in order to better understand the attitudes of secondary school students towards computers. The survey involved 18,000 students in Grades 8-12. The results showed that sex differences with respect to attitudes towards computers are clearly established by Grade 8. Males are more interested in computers than females, and more confident in their potential for working with them. In both grades the girls strongly agreed with the statement "Females have as much ability as males when learning to use computers" but when asked to assess their own ability and self-confidence their attitudes changed. Participation in a compulsory computer literacy course did not necessarily change the attitudes of the girls. However, boys who had taken compulsory computer courses were more positive about computers than those who had not. For girls, the compulsory courses did not lead to increased confidence or interest in computers. Girls were also found to be less positive than boys in their attitudes towards math and science, but more confident than males in their attitude towards writing stories, essays and compositions. Boys were also found to use computers more than girls outside of school, both for games and other activities.

Davidson, M., and Hartley, R. "Women and Computer Workshops". Booklet produced for a workshop "Women and Computers". Melbourne, Australia: Victorian Institute of Secondary Education, October 1984.

In 1984 the VISE Task Force on Transitional Education and Equal Opportunity gave two workshops, "Women and Computers", aimed at women teachers and parents who had little or no experience with computers. This paper documents what was learned at these workshops and gives information useful to others who may wish to run similar workshops aimed at raising the awareness of the issues related to girls' access to computer studies.

Equal Opportunities Commission (EOC), Information Technology in School: Guidelines of Good Practice for Teachers of IT. Manchester: Borough of Croydon, London, 1983.

These guidelines have been produced for the Equal Opportunities Commission by the London Borough of Croydon. Information technology is a new addition to the school curriculum and yet statistical evidence already demonstrates that boys are predominating in this subject area. This book discusses the introduction of computers in schools and the use of computers across the curriculum, with separate chapters for primary and secondary schools. It also gives guidelines for the school and the teacher for equitable use of computers.

Fetler, Mark. "Sex Differences on the California Statewide Assessment of Computer Literacy". Sex Roles 13 (1985), pp. 181-191.

During the 1982-83 school year, a statewide survey of Californian sixth- and twelth-grade students was conducted to ascertain their knowledge, attitudes and experience in the areas of computer science and computer literacy. The results showed that in both grades, in most of the curriculum objectives surveyed, boys used computers more both at school and at home. They also tended to have more positive attitudes toward the role of computers in the workplace.

Fisher, Glenn. "Access to Computers". The Computing Teacher 11 (April 1984), pp. 24-26.

The three main reasons why the girls in a California classroom were less interested in computers than the boys were: (i) male bias of the software; (ii) social bias (stereotypes, peer pressure, and the boys' behaviour); (iii) the content and structure of programming as an introduction to computers. These three problems are explained in detail and specific activities for intervention are discussed.

Gilliand, Kay. "Equals in Computer Technology". The Computing Teacher 11 (April 1984), pp. 42-44.

The actions of parents and society combine to demonstrate to girls that computers are not for them. The expanding need for women in the technological fields, though, means their image of computing as a male-dominated field must be changed. This change must start in the schools whereby females are made aware of the importance of computers and develop proficiency in their use in order to increase their career options. The positive attitudes and skills of teachers, counsellors, and administrators can go a long way

towards ameliorating the effects of decades of negative social conditioning of females. EQUALS, a program of the Lawrence Hall of Science at the University of California, Berkeley, alerts teachers to their students' attitudes towards computers and provides them with classroom strategies and materials designed to encourage girls to participate in computer courses.

Gripshover, Nancy A. Preventing Gender-Role Stereotypes in Classroom Computer Use: The Importance of Creating the 'Right Conditions'. November 1984, ED 247 908.

This paper explores the potential for gender-role stereotypes to interfere with the constructive integration of computers into elementary and secondary school classrooms. Gender-related differences in perceptions of abilities in mathematics and science are suggested to be the precursors of similar perceptions regarding computer use. Literature pertaining to the development of gender-role perceptions and the effects of these perceptions on self-image and achievement is examined. The influence of the context of the learning is discussed. Methodological constraints in gender-role research and directions for the conceptualization of new research are also described.

Gutek, Barbara A., and Bikson, Tora K. "Differential Experiences of Men and Women in Computerized Offices". Sex Roles 13 (1985), pp. 123-135.

This study looks at data from two questionnaires given to workers in 55 offices to see if the implementation of computerized procedures in offices differentially affects men and women employees. Preliminary analyses suggest that men do benefit more than women in terms of career advancement. The men in the study are better educated and bring more relevant skills to the workplace, hold more influential positions there, and make more computer related decisions. This is due in part to the organization of the office where men generally occupy positions of authority and women hold lower status positions. The women, however, were found to be satisfied with the training they received and with their experiences in the computerized office.

Hawkins, Jan. Computers and Girls: Rethinking the Issues. Technical Report No. 24, National Institute of Education, Washington, D.C., 1984.

This paper presents a framework for thinking about the emerging evidence of differences between boys' and girls' interest in and use of computers. Computers are often included in the math/science/technology category in education, as well as in the overall culture. This conceptual placement has implications for how they are implemented in the learning settings. A brief review of the literature about the possible reasons for observed sex differences in the area of mathematics is presented as a background for considering questions about computers. Evidence about sex differences in computer use from several studies conducted at the Center for Children and Technology is presented. Research in mathematics learning and studies with computers suggest that it is not simply the subject

area or the technology that produces the apparent differences, but rather the ways in which these tools are made functional for children.

_____. "Microcomputers in the Schools: Impact on the Social Life of Elementary Classrooms". Journal of Applied Developmental Psychology 3 (1982), pp. 361-373.

Two studies were conducted to examine the possible social effects of the use of computers in elementary classrooms where children are learning to work with Logo. In the first study, the task-related interaction that children engaged in with each other was observed and recorded in two classrooms of children 8-9 and 10-11 years old while they worked on both computer and non-computer tasks. The results showed that children in both classes were significantly more likely to collaborate with each other when they worked with the computers. The second study, using the same classrooms, examined children's perceptions of their peers as resources for help with a variety of classroom tasks. When compared with other work, the computer context was the one where children more consistently identified certain of their peers as sources of help. In both groups, two boys were frequently nominated by their peers as experts. In neither class were girls identified often as computer experts. In both classes girls selected boys as experts. When a girl was selected as a helper, she was always selected by another girl.

Howe, Jim. "Logo Programming and Intermediate Mathematics". Computers in Education 2 (March 1985), pp. 7-10.

This article reports on the findings of a research study by Dr. Jim Howe, professor of Artificial Intelligence at the University of Edinburgh, Scotland. The study was carried out at a state secondary school in Edinburgh in collaboration with the staff of the mathematics department. It involved approximately 80 students in each of the control and experimental groups. Pre- and post-tests were given to all students. These tests indicated that there was no significant difference between the experimental and control groups at the start or end of the project. However, when the results were reanalyzed by sex, differences appeared with the female Logo group showing improvement over the control female group and the control male group at the end of the year.

Hoyles, Celia, and Sutherland, Rosamund. "The Logo Maths Project: A Preliminary Investigation of the Pupil-Centred Approach to the Learning of Logo in the Secondary School Mathematics Classroom". Report funded by the Leverhulme Trust and North London Polytechnic, 1984.

This report consists of case studies of 7 pairs of high school students using Logo in the mathematics classroom. No differences in levels of motivation or achievement, or differences in the nature of the challenge of the project chosen were observed between the male and female students. There were differences in approach. The boys were more likely to try out unknown keys on the keyboard and often appeared to be more "physically" enjoying the computer work. However, the girls' self-contained and more reflective approach to

using the computer must not be taken as reflecting on lower levels of interest, or a lower level of programming skills.

Johnson, Brian D. "Female Terror at the Terminal". Maclean's, July 18, 1983, pp. 45-46.

At computer camps across Canada boys outnumber girls two to one. Many girls are jeopardizing their future job prospects by deciding in their teens that computers are better left to the boys. Not only do boys and girls approach computers in unequal numbers, but also with different attitudes. Sex stereotyping is not confined to computer education but is endemic to the discipline of mathematics and science which are essential tools for basic programming.

Kiesler, Sara; Sproull, Lee; and Eccles, Jacqueline S. "Second Class Citizens?". Psychology Today 17 (March 1983), pp. 41-48.

Cultural factors and expectations rather than inherent disadvantages in capabilities seem to keep girls out of arcades and away from computers. The culture of computing as being overwhelmingly male is discussed.

Kolata, Gina. "Equal Time for Women". Discover, January 1984, pp. 24-27.

There is no question that girls are as qualified as boys to learn about computers. According to national tests in the United States, female high school students who take computer science perform as well as the males. But, in school, at every grade from Kindergarten through graduate school, women are underrepresented. This is of great concern because avoiding computers means closing the doors on a wide range of careers. The reasons for these differences, primarily social, are discussed together with examples of the special efforts some schools are making to rectify the situation.

Kreinberg, Nancy, and Stage, Eliabeth K. "Equals in Computer Technology". In The Technological Woman; Interfacing with Tomorrow, edited by Jan Zimmerman. Praeger Special Studies, 1983, pp. 251-259.

The increasing use and importance of computers in the workplace poses a serious threat to those who are unprepared to use them, and a tremendous opportunity to those who are prepared to control this new technology. Who will that be? This article outlines the current answers to that question and discusses the educational strategies that may alter that response. Changes must take place both in and outside schools so that women will have equal access to computer technology. Early intervention is very important; elementary teachers are the key to the solution.

Kruger, Marilyn. "Girls and the New Technology". FWTAO Newsletter, April/May 1985, pp. 42-45.

This article stresses the need for women to be trained in technology if they are to take an equal place in the work force. In Canada, as in the United States, twice as many boys as girls are enrolled in computer science courses. In order to ensure that all students are adequately equipped to use computers, educators and parents must both be made aware of the sex equity problem. More research must be undertaken in Canada to determine the extent of the problem and to find the most effective solutions. Suggestions for intervention are discussed.

Lai, Morris K. "Evaluating a Computer Educational Program Qualitatively and Quantitatively". Paper presented at the American meetings of the American Educational Research Association, New Orleans, April 1984.

Despite the tremendous popularity of computers in education there have been few examples of evaluations of computer education programs. This paper discusses a qualitative/quantitative evaluation of an 80-hour program that integrated computers with mathematics and science involving 370 secondary school students. Gains were shown in computer programming skills, mathematical problem solving, and attitudes toward computers. Sex differences were found in cognitive gain, use of computer laboratories, and discipline.

Linn, Marcia C. "Fostering Equitable Consequences From Computer Learning Environments". Paper presented at the annual mid-year conference of the American Educational Research Association, Research on Women and Education Special Interest Group, Tempe, Arizona, November 1983.

This article describes the ways in which computer environments for learning have the potential for fostering cognitive skills for all students. It characterizes the gap between the potential of computers in education and the reality of their use in classrooms. It also documents the differential participation of males and females in computer experiences, and describes two studies of male and female responses to computer learning environments. In addition, it suggests future actions to foster equitable outcomes from computer learning environments.

Lockheed, Marlaine E., and Frakt, Steven B. "Sex Equity: Increasing Girls' Use of Computers". The Computing Teacher 11 (April 1984), pp. 16-18.

A number of recent studies have indicated that while boys and girls have similar appreciation of the significance computers will have on their personal future, boys are gaining a greater working knowledge of computers by spending more time doing hands-on computer-related activities. Boys are much more likely than girls to use the computer room at school outside of class time; to have access to a computer at home or at a friend's house; to frequent computer stores; to attend computer camps. The reasons for the differences in

access to computers by boys and girls are discussed under the headings "sex segregation", "social context", "costs" and "relevance of the computer curriculum." Suggestions for teachers to encourage girls and make the computer programme more equitable are also given.

Lockheed, Marlaine E. "Women, Girls and Computers: A First Look at the Evidence". Sex Roles 13 (1985), pp. 115-122.

This article suggests that while computers may best be studied from the perspective of function (e.g., as an object of study, a tool, or for recreation), most research on sex differences in computer use has not made this distinction. It does appear, however, that sex differences in computer use emerge for certain uses and not for others. Males use computers more for programming and playing games but not for other computer applications. Three different applications are addressed: the computer as an object of study (programming and computer literacy courses); the computer for recreation (playing games); the computer as a general-purpose tool (word processor, data base management, spreadsheets, graphics, music). Possible explanations for these sex differences in the use of computers are given.

Lopinski, Judith M. "Computers, Gender and Preschooler's Free Play Choices When a Microcomputer is Present in the Classroom". Report of the Children and Technology Project, Family Research Center, University of North Carolina, Greensboro, 1984, ED 243 609.

Two studies examined children's activity choices in a one-hour free-play period. Sex, competence and free-play areas were independant variables. The first study involved a class of 4-year olds at a university-based nursery school. A class of children the same age at a university day care centre was utilized for the second study. A microcomputer with age-appropriate software was placed in each classroom. The presence of the microcomputer initially disrupted children's free-play choices but after several weeks the children's free-play patterns returned to baseline levels. In the first study, girls spent more time on the computer than the boys. There were no significant sex differences in the second study. In both studies, high- and medium-competency children spent equal amounts of time at the computer.

Lloyd, Brenda H., and Gressard, Clarice. "The Effect of Sex, Age, and Computer Experience on Computer Attitudes". Paper presented at the annual meeting of the Eastern Educational Research Association, February 1984, ED 246 878.

Student attitudes towards computers are important to their success in computer related programs. This study of 254 high school, community college, and college students examines the effects of age, sex, and computer experience on their attitudes (i.e., computer anxiety, confidence, and liking) measured by the Computer Attitude Scale (Lloyd and Gressard 1984). Computer experience was found to be significantly related to a more positive attitude on all three subscales. Some significant age effects were also found,

but no clear trend with age was demonstrated. Sex was not found to be significantly related to computer attitude on any of the three subscales.

Mandinach, Ellen B., and Corno, Lynn. "Cognitive Engagement Variations Among Students of Different Ability Level and Sex in a Computer Problem Solving Game". Sex Roles 13 (1985), pp. 241-253.

This study looked at the cognitive engagement processes used by 48 junior high school students of different ability and sex when working on a problem-solving game called "Wumpus". This is a computerized "hunt the monster" game in which the student's goal is to track and kill a mythical creature while avoiding various hazards. To be successful in this game requires deliberate and efficient application of strategic planning and logical reasoning processes which define self-regulated learning. Results showed that the main difference between students was in their spontaneous use of self-regulated learning processes. The more successful students appeared to shift cognitive engagement levels in response to computer game feedback. On average, males and high-ability students were more successful.

Maripodi, Maryann R. "Females and Computers? Absolutely!". The Computing Teacher 11 (April 1984), pp. 57-58.

This article discusses the five common problems found in the classsroom: (i) the aggressiveness of boys compared to girls; (ii) the male bias in software and computer-related material; (iii) the differing attitudes of boys and girls towards the usefulness of computers; (iv) the identification of computers as a male activity; (v) societal stereotypes affecting classroom behaviours. Suggested strategies for classroom intervention are also given.

Marshall, John. "Beyond the Bandwagon: Some Problems and Promise of Educational Computing". Occasional paper, 1984, ED 255 190.

As state-mandated computer campaigns to teach computer literacy are launched across the U.S. it is important to consider carefully the issues surrounding educational computing that are related to classroom computer use, and the social implications of computing. Two of these concerns are equity and gender. Teachers must ensure that educational computing is used to compensate for, rather than reinforce social inequities and differences in ability. In both elementary and high schools, computers seem to belong to the "males". Both of these issues can be addressed successfully when teachers organize computer instruction and usage around the themes of creating, informing, and communicating rather than around the machines themselves. These themes stress the importance of the computer as a user-controlled and user-beneficial tool.

McKelvery, Betsy. "Sex Roles and Computer Use: A Study of Equity in the Classroom". Paper presented at the Annual Conference of the Association for Educational Communications and Technology, January 20-24, 1984.

This study is based on 50 hours of observations at four different schools in Toronto. The overall impression was that boys enjoyed working with computers more than girls did; that there was a different type of computer activity preferred by girls and boys; that girls appeared to need more structure and used the documentation more; that girls were not as experimental as boys. Suggested topics for further research are also included.

Menzies, Heather. "Computer Technology and the Education of Female Students". An information paper for the Canadian Teachers Federation.

This paper considers the workplace of the future with particular reference to the automation of employment, the position of women in the labour force, and the implications of this changing labour market on education and the role of teachers. It suggests ways in which education may have to change in response to the new demands.

Miura, Irene, and Hess, Robert E. "Sex Differences in Computer Access, Interest and Usage". Paper presented at the 91st annual convention of the American Psychological Association, Anaheim California, August 1983.

Three studies looking at differences in access to, interest in, and usage of computers by the school-age population are discussed in this paper. Study 1 considers home ownership of computers by middle school students. It shows that boys are more likely to have computers at home than girls and that boys use home computers more frequently than girls. Study 2 looks at the enrolment in summer computer camps and classes. Results show an enrolment pattern three to one in favour of boys for all grade levels. The proportion of girls enrolled in these classes declines as the difficulty increases and also as cost of the courses rises. Study 3 looks at sex-typing in the titles of computer software. Most of the computer activities are perceived as being developed primarily for males rather than females.

Moore, Barbara G. "Sex Differences in the Classroom Use of Logo". Paper presented at the Educational Computing Organization of Ontario Conference, Toronto, 1984.

This paper discusses the sex differences in the use of computers in a Grade 6/7 classroom involved in a research project to look at the creative use of computers in the classroom. The classroom was observed over a two-year period. During the first year no sex differences in the classroom use of computers were observed by the teachers or the observers, but on a Logo test given at the end of the year, the boys performed significantly better than girls. In identifying reasons for this, it was found that boys had more computer time, both during and after school, were more likely to have a computer at home and were given

more encouragement by their parents. The use of their computer time was also different. Boys liked to program; girls to draw pictures. Boys' and girls' attitudes towards computers were also different. At the end of the two years the boys were very confident and enthusiastic about computers, but the girls' confidence dropped and several were no longer interested in using computers.

Ontario Federation of Women Teachers Associations of Ontario. Response to Computers in Ontario Education. Toronto: FWTAO, 1984.

This document is a response to the Ontario Ministry of Education's final report "Computers in Ontario Education". In addition to addressing the five areas covered in the report, curriculum, teacher training, software development, hardware and information networks, and research priorities, this book discusses the important issues of gender equity and the use of computers. It documents the problem and gives suggestions for correcting the situation.

Piestrup, Ann McCormick. "Preschool Children Use an Apple III to Test Reading Skill Programs". Portola Valley, California: Advanced Learning Technology Institute, January 1981.

Fifty-five preschool children 3-4 years old used the Apple II computer to learn the reading readiness concepts of "above", "below", "left", and "right". The computer was used for indoor play sessions for three weeks. Color graphics, music, and voice response to keyboard inputs by the children were elements of the program. More girls than boys asked for turns on the computer and succeeded in getting them. Boys seemed less able to wait to start their turns, but it should be noted that there were more girls than boys in the classroom. The graphics and music were designed to be sex-neutral. The digitized voice on the computer had both male and female segments. Usually a woman monitored the computer. The only time there was a significant change in the number of boys versus girls approaching the computer was when a male programmer visited. Then the boys came immediately to the computer and stayed throughout the session with very few girls participating.

Project on Equal Education Rights (PEER). Sex Bias at the Computer Terminal - How Schools Program Girls. Computer Equity Report. Washington D.C.: Project on Equal Education Rights, 1984.

Surveys of classroom enrolment patterns consistently show that girls are not participating on an equal basis with boys in computer programming courses. At the high school level, boys outnumber girls two to one in the academic-based courses in computer programming. By contrast, girls outnumber boys by more than three to one in business education courses leading to jobs as word-processing equipment operators and data entry clerks. This enrolment pattern appears to have nothing to do with ability or performance. A more subtle influence is at work: boys, with the tacit approval of the schools, develop a computer subculture which excludes girls. The barriers are both structural and psycho-

logical. Computer programming courses are often offered in the math departments and often treated as advanced studies reserved for the brightest math students, traditionally assumed to be male. Girls often perceive computer programming as too difficult. This "gender gap" in perceived abilities could be overcome by requiring a course in basic computer literacy for all students. Once girls overcome their anxieties they perform as well as boys. The lack of trained computer educators aggravates inequities in enrollment. Frequently students' and teachers' roles are reversed when it comes to computer instruction. In the hurried attempts to retrain teachers, equity issues are largely ignored.

Reimer, Gordon. "The Effects of a LOGO Computer Programming Experience on Readiness for First Grade, Creativity and Self-Concept: 'A Pilot Study in Kindergarten'". AEDS Monitor 23 (January/Febuary 1985), pp. 8-12.

The aim of this study was to determine whether learning Logo in a Logo environment for 35-40 minutes a day over a period of a month, would have any effect on Kindergarten childrens' creativity, self concept, and readiness for the first grade. Sixteen students were involved, eight in the control group and eight in the treatment group. All were given pre- and post-tests. Results showed students in the treatment group had greater gains in ten of eleven readiness tests, both in creativity measures and in the self-concept test. Gender had little effect with only one of the ten tests showing any sex differences. In this test, females in both treatment and control groups showed lower gains than males, but the females in the treatment group showed higher gains than the females in the control group.

Rose, Raymond. "Identifying Equitable Software". The Computing Teacher 11 (April 1984), pp. 51.

More than twenty states of the United States have state laws, regulations, or policies requiring that all instructional materials are reviewed for equity. A software evaluation form is given as a guide to use in evaluation.

Sanders, Jo Shuchat. "The Computer: Male, Female or Androgynous". The Computing Teacher 11 (April 1984), pp. 32-34.

The Computer Equity Training Project, conducted by the Women's Action Alliance of New York is a national project to look at three important areas: why girls seem to avoid computers; the affect of this avoidance; what educators can do to reverse this trend. To find the answers, the staff of the Computer Equity Training Project conducted a thorough review of the literature and spoke with many people, especially junior high school teachers. Twenty-nine possible explanations for the observed differences in computer use by boys and girls of junior high school age are listed.

_____. "Making the Computer Neuter". The Computing Teacher 12 (April 1985), pp. 23-27.

This article is an update of the previous article. It deals with several inequity aspects; women in the computing media; how home computer use varies by sex; a student software evaluation; female versus male teachers; the influence of peers. It also updates some of the previous findings.

_____. "Here's How You Can Help Girls Take Greater Advantage of School Computers". The American School Board Journal 172 (April 1985), pp. 37-38.

This article describes how sex equity programs in schools can improve the educational environment for boys as well as girls. The key to closing the gender gap in computer use is in recognizing it exists and that recognition must start at the top in the various school systems. Teachers must operate within guidelines established by school boards and superintendents. Given the widespread community support for computers in education, school board members are relatively free to set bold policy that will ensure equitable computer access and use in schools throughout the school system. Suggestions for policy action addressing problems involving computer use and equity are given.

_____, and Stone, Antonia. The Neuter Computer: Computers for Girls and Boys. O'Neill-Schuman, n.d.

This book is based on the research of the Computer Equity Training Project of the Women's Action Alliance. This project working with schools across the U.S.A. was very successful. Schools that used the neuter computer reported an increase of 144% in girls' computer use in just one term. There were no changes in the control group not using the book. The book contains computer activities, computer equity strategies, and resources for teachers.

Schubert, Jane G., and Bakke, Thomas W. "Practical Solutions for Overcoming Inequity in Computer Use", The Computing Teacher 11 (April 1984), pp. 28-30.

This article describes an ongoing study at the American Institute for Research (AIR) in Palo Alto, California. The study is designed to help teachers provide equal opportunities for primary, intermediate, and junior high school students who want to learn about and use computers in school. Although most teachers do not intentionally treat some students unfairly they often do so. A result of this inequitable treatment is that student opportunities to learn are minimized or lost. From observations and interviews of children in Grades 1-9 in individual classrooms, learning centres, and computer laboratories, the circumstance and situations that limit access to computers for some students have been documented. This study produces a comprehensive definition of the factors that lead to inequitable access to computers and computer knowledge for females and minorities. It lists potential solutions to create equitable access, and provides a self-assessment instrument for use by teachers, to identify the inequitable access factors operating in school districts and classrooms.

Sheingold, Karen; Kane, Janet; and Endreweit, Mari. "Microcomputer Use in Schools: Developing a Research Agenda". Harvard Educational Review 53 (1983), pp. 412-432.

This article reports on three case studies conducted by the Bank Street College of Education to reveal how different school systems used computers for instruction. Through interviews and investigations, three geograpically distinct school districts with diverse computer aplications at both the elementary and secondary school levels were investigated. Six trends emerged which raise important questions for future study: access to computers; emergence of new roles in response to computers; integration of microcomputers into elementary classrooms and curricula; quality and quantity of the software; preparation of teachers for using computers; the effects and outcomes of the instructional use of computers. Sex differences in access to and use of computers was noticed.

Sprigle, Joan E.; and Schaefer, Lyn. "Age, Gender and Spatial Knowledge Influences on Preschoolers' Computer Programming Ability". Early Childhood Development and Care 14 (1984) pp. 243-250.

The aim of this study was to determine whether there is a relationship between spatial knowledge and memory for language, and the mechanics of programming. Thirty-one children, 14 boys and 17 girls, were observed while performing four computer tasks. Although improvements were shown in both tasks, there was only a small relationship between the childrens' predicting ability and their programming ability. Gender had no effect on either task.

Stasz, Cathleen; Shavelson, Richard; and Stasz, Clarice. "Teachers as Role Models: Are There Gender Differences in Microcomputer-Based Mathematics and Science Instruction?". Sex Roles 13 (1985), pp. 149-163.

Questionnaires were given to 60 teachers (31 female, 29 male) to see if there were differences for male and female teachers in their background or training for the instructional uses of microcomputers, and in their uses of microcomputers to teach mathematics and science. No gender differences were found. Male and female teachers both had similar academic backgrounds, were equally knowledgeable about computers, and displayed similar teaching styles. Both male and female teachers were found to provide leadership in computer use and to present equally viable role models for their students.

Turkle, Sherry. The Second Self: Computers and the Human Spirit. New York: Simon and Schuster, 1984.

Two different styles of mastery are discussed, hard mastery and soft mastery. Hard masters see the world as something they can bring under their control. From an early age they have preferred to work with the manipulable, such as blocks, tinker toys, and mechan-

isms. These children take avidly to computers. Soft masters are more likely to see the world as something they have to accomodate to, something beyond their control. They have tended to play with toy soldiers and dolls and in doing so have learned to negotiate, compromise, and empathize. Scientific and technical fields are usually seen as a natural home for the first group of children and the arts and humanities for the other. Girls tend to be soft masters and boys are overwhelmingly hard masters. In our culture girls are taught the characteristics of soft mastery, negotiation, compromise, and give-and-take as psychological virtues, while models of male behaviour stress decisiveness and the imposition of will.

Vermette, Sandra M.; Orr, R. Robert; and Hall, Michael H. "Attitudes of Elementary School Students and Teachers Toward Computers in Education". Educational Technology 26 (January 1986), pp. 41-46.

This study examines the attitudes of teachers and students towards computers in the classroom. A 22-item questionnaire was given to 116 elementary school students (Grades 3-6) and 50 elementary teachers. Sex differences in attitudes were not apparent in either the student or teacher responses, but there was evidence of sex-role stereotyping, such as the belief that computers were somewhat a male domain.

Ware, Mary Catherine, and Stuck, Mary Frances. "Sex-Role Messages vis-a-vis Microcomputer Use: A Look at the Pictures". Sex Roles 13 (1985), pp. 205-215.

This study analysed the illustrations in magazine articles and advertisements to determine the numbers of men, women, boys, and girls pictured, the roles in which they were portrayed, and whether they were shown actively using a computer, watching others use a computer, or rejecting the computer. Three issues of three mass market computer magazines with a total of 3,637 pages were analysed. Many stereotypical portrayals were found. Men appeared in illustrations almost twice as often as women and the women were often represented as clerical workers and sex objects; men were often represented as managers, experts, and repair technicians. Women were shown significantly more often in a passive role vis-a-vis computers. In mixed-sex illustrations, men were most often shown in the position of authority. Only women were shown rejecting the computer, or portrayed as sex objects. This article also includes observations regarding the effects of stereotypical portrayals on women and girls and gives suggestions for further research.

Watkins, Marley W., and Abram, Sandra. "Reading CAI with First Grade Students". The Computing Teacher 12 (April 1985), pp. 43-45.

The first grade class of a surburban school in Iowa (47 girls and 56 boys), received reading instruction for 45 minutes per week using CAI. Pre- and post-tests were given. After twelve weeks of CAI instruction significant results were noted on the reading tests. Boys performed as well or better than girls on the reading test following CAI.

Watt, Dan. "Bridging the Gender Gap". Popular Computing, 1984, p. 54-59.

The use of microcomputers in the schools is seen as a great equalizer. It was believed that if children were introduced to computers at an early age, and if schools maintained equal access to them throughout the grades, girls, by the time they graduate, would be as well qualified as boys for careers as computer professionals. This, however, may not be the case. Research has shown that children start with equal access, but after a few years the boys outpace the girls. The reasons for these sex-related inequities are discussed and possible remedies are given.

Wilder, Gita; Mackie, Diane; and Cooper, Joel. "Gender and Computers: Two Surveys of Computer-Related Attitudes". Sex Roles 13 (1985), pp. 215-229.

This article discusses the results of two surveys which looked at gender and computers. In one survey questionnaires were given to 1600 students in grades K-12 in a suburban school district of New Jersey, to measure the students perceptions of sex-typing and liking for computers and video games. Results showed that both boys and girls perceived the computer to be more appropriate for boys than girls. Boys perceived the computer to be slightly more appropriate to boys than did girls. Boys also liked the computer more than girls at all ages. Video games were also perceived to girls at be more appropriate for boys than girls and boys liked them more. Similar results were seen in the attitudes towards science. Writing was seen to be more appropriate for and liked more by girls. The second study involved a group of highly motivated college freshmen. Results showed that computers were no longer considered part of the male domain, but attitudes and interactions with computers seemed unchanged.

Woodill, Gary; Anderson, Karen; and Bernhard, Judy. "Sexism, Computers, and Young Children". Paper presented at the ECOO/AEDS Conference, Toronto, April 1985.

Research has shown that computers in classrooms are often monopolized by boys. This paper examines the literature on this issue with particular reference to preschool children. It also discusses the preliminary results of a pilot study where a computer was used in a daycare center. Differences in computer use by boys and girls were observed. Explanations for these differences and strategies for dealing with the problem are given.

II. MATHEMATICS AND SCIENCE

Allerdice, Frances Witte. "Observations from Secondary School Science Classes". Canadian Women's Studies Journal 1984.

From observations made in various science classes (physics, chemistry and biology), in both junior and senior high schools in a small New England town, it was shown that boys and girls in the same class are treated differently. Girls were shown the answers to problems; boys were given further instructions or questioned to help them solve the problems independently. This differential treatment of the boys and girls leads to a dependence on the teacher, and a lack of self-confidence with regard to scientific learning on the part of the girls.

Badger, M.E. "Why Aren't Girls Better at Maths? A Review of Research". Educational Research 24 (November 1984), pp. 11-23.

Until recently the belief that boys are better than girls in mathematics has not been challenged. This paper reviews the research and examines the evidence for discrepancies in performance. The influence of spatial ability, attitudes, cultural factors, and school factors on mathematics performance are all considered. It is concluded that the main reasons for the lack of success by girls in mathematics are social and cultural attitudes, which are particularly powerful during adolescence. Girls tend to underestimate their performance in general, particularly in subjects considered to be male activities.

Becker, Joanne Rossi. "Differential Treatment of Females and Males in Mathematics Classes". Journal of Research in Mathematics Education 12 (1981), pp. 40-53.

Teacher interactions with males and females in ten high school geometry classes were noted during ten classroom observations to determine whether differential treatment of the sexes occurs in highschool mathematics classes and to identify what, if anything, occurs in such classes that negatively affects the continued study of mathematics by young women. The study concluded that the students were learning mathematics in an environment that sex-typed the subject as male, that provided males more formal and informal reward and support in mathematics, and gave them more outlets for classroom academic achievement and recognition. It showed that teachers have different expectations of students based on the sex of those students and that students were treated differently on the basis of sex, in ways consistent with those expectations. Students respond differently in class in accordance with the expectations of teachers and society of the sex roles.

Berryman, Sue E. Who Will Do Science?: A Special Report. U.S.A.: The Rockefeller Foundation, 1983.

This report looks at the trends and the causes of female underrepresentation among holders of advanced degrees in science and mathematics in the United States. In the past decade females have earned an increasing percentage of the degrees conferred at every level, but they are still underrepresented in doctoratal and professional degrees. The reasons for this are discussed.

Eddowes, Muriel. Humble Pi! The Mathematics Education of Girls. York, England: Longmans, School Council Programme, 1983.

This booklet is the result of a joint venture between the schools' council, which is in charge of developing school curriculum, and the Equal Opportunities Commission, which is concerned with the promotion of sex equity. Mathematics was the first of a series of pamphlets on sex differences to be produced in various areas of curricula. In England, as in other countries, the proportion of girls involved in mathematics decreases rapidly as the level of difficulty in the mathematics courses increases. This booklet considers the problem, outlines some of the reasons, and offers practical suggestions for remedying the situation.

Entwistle, Doris, and Baker, David. "Gender and Young Children's Expectations for Performance in Arithmetic". Developmental Psychology 19 (1983), pp. 200-209.

A study of 1,000 children in two Baltimore schools during their first three years of school suggests that the school experience is different for boys than it is for girls, even though the children sit together in the same classroom with the same teacher. Twice a year the children's expectations for their marks in arithmetic, reading, and conduct were ascertained together with the parental expectations for these same marks. Although there were no significant differences between the boys' and girls' arithmetic marks, the boys expected better marks than the girls. The girls expected to do worse in arithmetic than was warranted by their marks. In this middle-class school, at each grade level, the parents expected the boys to get better marks than the girls in arithmetic, and the girls to get better marks in reading. The girls' higher expectations for reading were justified by better average marks and a higher general achievement.

Fennema, E. "Teachers and Sex Bias in Mathematics". The Mathematics Teacher 73 (March 1980), pp. 169-173.

The day-to-day interaction with teachers is the most powerful influence on students. Their feelings about themselves as learners of mathematics, their perceptions of the usefulness of mathematics, and their willingness to continue to study mathematics beyond the minimum requirements are all influenced by the teachers. There is evidence to suggest

that teachers are treating males and females differently with the result that females receive inadequate mathematics education in high school.

Gore, Dolores, and Roumagoux, Daniel V. "Wait-Time as a Variable in Sex-Related Differences During Fourth Grade Mathematics Instruction". Journal of Educational Research 76 (June 1983), pp. 273-275.

The aim of this study was to see if there was any difference in the teacher wait-time for high, medium and low academic achievers or between the wait-time allowed for boys and girls. Seventy-nine fourth grade boys and 76 fourth grade girls in five classrooms were studied during mathematics instruction. The results showed that teachers gave significantly more wait-time to boys than to girls. This difference in wait-time could have a negative effect on girls' achievement in mathematics.

Her Majesty's Stationery Office. Girls and Science. London: Her Majesty's Stationery Office, 1980.

This report discusses the teaching of science at coeducational schools in England. The enrolment patterns of girls in science vary considerably from school to school. This booklet examines the measures taken at the schools where there is a higher than average proportion of girls enrolled in chemistry and physics courses. The factors considered are; the school and its environment; curriculum; staffing; teaching methods and curriculum in the science department. Even in this select group of schools, the students considered physical science to have a masculine image and teachers often questioned why girls took these subjects. Once a tradition had been established that a high proportion of girls took physical science each year, it became easier to maintain the size of the group of girls. Science was perceived as difficult and most of the girls took it for career reasons, or because they were good at it. Few studied it because they enjoyed it. Most of these schools had compulsory craft classes for the first and second years of high school. Girls took woodwork, design and technology, and technical drawing; boys took needlework and cooking.

Koehler, Mary Schatz; and Fennema, Elizabeth. "Women and Mathematics: Is There a Problem?". In Education in the 80's: Mathematics, edited by Shirley Hill, pp. 94-107. Washington, D.C.: National Education Association, (1982).

This chapter looks at the past and current situation in the U.S. regarding the differences in performance and enrolment of males and females in high school mathematics courses. The reasons for these sex differences are discussed under three headings: (i) confidence in one's mathematics ability; perceived usefulness of mathematics; perception of mathematics as a male domain; (ii) influence of other people (e.g., teachers, counsellors, peers, and parents); (iii) overall school influence. Ways of implementing solutions to the problem are also discussed.

Kreinberg, Nancy. "1,000 Teachers Later: Women, Mathematics and the Components of Change". Bulletin of the Institute of Governmental Studies 22 (August 1981), n.d.

Started in 1977, EQUALS is a program designed to help educators increase the participation of girls and women in school mathematic courses. Its aim is to increase the teacher's awareness of the issues related to math avoidance among females and make them aware of the consequences of such avoidance. This program also provides teachers with strategies and materials to encourage students to take part in math courses, and to understand the relevance of mathematics in their career choices. This report describes what has been learned and what changes need to be made to improve the educational and occupational opportunities of young women.

Leder, Gilah. "Bright Girls, Mathematics and Fear of Success". Educational Studies in Mathematics 11 (1980), pp. 411-422.

In a review of the relevant literature two important areas of sex differences in the field of mathematics emerge: considerably more boys than girls do well in mathematics; girls more frequently than boys choose not to take intensive mathematics courses as an elective. There are several explanations for these differences in participation and performance in mathematics. Many relate to environmental factors and are part of a broader area of sex differences in role expectations and behaviour. This paper reports on two studies that look at the relationship between fear of success and performance and participation in mathematics courses. The results show the effect of environmental and social pressures. The girls who were aware of the social pressures associated with career choice and the negative consequences of contravening social conventions, tended to have a lower performance in mathematics than girls less concerned about these issues. Possible classroom-based interventions are discussed.

_____. "Sex Related Differences in Mathematics: An Overview". Educational Studies in Mathematics 16 (August 1985), pp. 303-320.

Beliefs and prejudices about sex appropriate behaviours are reflected in the expectations of parents, peers, school, and society. Students' achievement in mathematics is related to their parents' educational and socioeconomic status. Organization of the school and teacher behaviour expectations and beliefs are also important in encouraging participation in mathematics. Sex-role differentiation through sex-typed leisure activities, subject preferences, and career intentions is further perpetuated by the peer group. Males tend to aim for achievement in intellectual expertise and leadership skills (areas which have traditionally been given high value). Females seek achievement in areas that require social skills.

Leinhardt, Gaea; Seewald, Andrea Mar; and Engel, Mary. "What's Taught: Sex Differences in Instruction". Journal of Educational Psychology 71 (1979), pp. 432-439.

Research shows that boys' and girls' performance on mathematics and reading tests differ: boys perform better on mathematics tests and girls perform better on reading tests. This study looked at teacher/student interactions in second grade classrooms to see if there were any reasons for these differences. The results showed that teachers made more academic contact with girls during reading and with boys during mathematics, and spent more cognitive time with girls in reading, and with boys in mathematics. They also made consistently more managerial contacts with boys than with girls. Although there were no differences in initial abilities, sex differences were found in the end-of-year achievement in reading. Data was based on 33 classrooms containing a total of 726 students (354 girls and 372 boys).

Lipovenko, Dorothy. "Why Joanie Can't Add", The Globe and Mail, Thursday July 1, 1982.

Professor Toepfer, Department of Curriculum Development, State University of New York, has teamed up with neurobiology Professor Herman Epstein, to test his finding that the brain growth of girls and boys occurs at different times, and to assess the implications of this for changing the structure of academic programs. Toepfer believes that male high school students perform better than their female classmates in math and science because the subjects are introduced when boys are experiencing their peak increase in brain growth (14-16 years). The girls receive their peak increase in brain growth from 10-12 years of age, and by high school they have lost their competitive edge. Unable to keep up with the boys, their self-esteem drops and they retreat from math and science. A Long Island School Board and a private academy in Michigan have started testing the Epstein/Toepfer theory. They are adjusting the curriculum to challenge the learning abilities of boys and girls during their growth spurts, paying special attention to the advantage girls have between the ages of 10 and 12.

Maccoby, Eleanor Emms, and Jacklin, Carol Nagy. "What We Know and Don't Know about Sex Differences". Psychology Today 8 (1974), pp. 109-112.

Over 2,000 books and articles on sex differences in motivation, social behaviour, and intellectual ability were reviewed to ascertain which generalizations were justified. Consequently, the researchers were able to determine which beliefs about sex differences are supported by evidence, and to discover which ones have no support and are still inadequately tested. It was found that males are more aggressive than females; girls have greater verbal ability than boys; boys excel in visual spatial ability; boys excel in mathematical ability.

Menzies, Heather. "Back to Grandma's Place: Democratizing Science and Technology". Canadian Women's Studies Journal: Science and Technology York University Centennial College Project, Summer 1984.

Whereas most literature discusses getting girls and women involved in science and technology, this paper discusses getting science and technology into women. It discusses the importance of transforming science through the perspectives and values of women, their experience, and their heritage.

Mura, Roberta. "Gender and Mathematics in Canada". Paper prepared for Faculty of Education, Laval University, n.d.

This article, based on a survey of relevant literature in Canada, discusses the differences in attitudes of boys and girls towards mathematics and the reasons for these differences. Environmental, social and cultural aspects are all considered.

Passmore, Biddy. "Impractical Girls Hust Lack Confidence". London Times (Educational Supplement) January 11, 1980, p. 9.

This is a report on the Sex Differentiation and School Conference in Cambridge, England. Dr. E. Fennema (University of Wisconsin) stated that lack of confidence on the part of many girls explains the superior achievement of boys in mathematics and science. Children are more confident in the subjects considered appropriate and useful to their sex, and mathematics has been considered part of the male domain. Carol Dweck (University of Illinois), another speaker, explained that the lower achievement of girls is a result of their concept of learned helplessness, which makes girls underestimate their ability and gives them less confidence to tackle new tasks and concepts. Learned helplessness is caused by the different patterns of praise and criticism given to the two sexes by the teachers.

Preece, Muriel. "Mathematics: The Unpredictability of Girls?". Mathematics Teaching 87 (June 1979), pp. 27-32.

This article is based on a five-year research project of Sheffield City Polytechnic, involving 1,250 second year students at a comprehensive school. Tests to assess basic computational ability and problem-solving ability, and a questionnaire on attitudes to mathematics were given at the beginning and end of the school year. Results showed no significant difference in the mean arithmetic scores of boys and girls either at the beginning or the end of the year. However, when problem solving is considered, differences between the boys' and girls' success rates emerged. The girls' success rate appeared to be influenced by the context of the problem. The overall attitude rating did not differ but profiles differed in detail. Boys showed a greater degree of self- confidence in the subject and greater expectation of success. Girls showed greater intrinsic interest in the subject and greater need for teacher support. During the year the overall scores for the boys increased and those for girls dropped with a swing to many more negative responses from the girls. Boys felt math was becoming more "challenging" whereas the girls conveyed an air of hopelessness. Girls did not expect to succeed and felt no one else expected them to either; so they wondered what was the point of trying.

Ridley, Dennis; and Novak, Joseph. "Sex-Related Differences in High School Science and Mathematics Enrolments: Do They Give Males a Critical Headstart Towards Science- and Mathematics-Related Careers?". Alberta Journal of Educational Research 29 (December 1983), pp. 308-318.

This article suggests that the sex-related differences in mathematics enrolments in high school and post-secondary institutions may result from a greater socialization of women into rote-mode learning strategies that are ineffective in advanced mathematics and science courses. Girls are encouraged to please the teacher by reproducing given material. This encourages rote learning. Boys, however, are encouraged by their peers to ignore the teacher. In addition, from an early age, boys are given more encouragement than girls to "tinker" with math- and science-related objects. This could result in a difference in attitude towards mathematics, and in willingness to persevere with it.

Russell, Sheila. "A Captive Audience". Mathematics in School 13 (January 1984), pp. 31-34.

The objective of this study was to compare the attitudes of girls and boys to their learning experience in mathematics, and in particular to attempt to find explanations for the relatively small number of girls who choose to study mathematics at the advanced level. A questionnaire was given to 299 students, 128 of whom were studying math and 171 who were not. Twenty-four students were later interviewed. Results of the research showed that girls did not consider mathematics as useful as did boys; some boys chose advanced level mathematics because it was expected of them, and because of its status with teachers and peers; many students found math boring; girls often chose other subjects but boys felt less free to do so; more girls than boys feel that enjoyment of a subject is a prerequisite for studying it at the advanced level; encouragement or lack of it by the teacher was considered important for girls.

Sawada, Daiyo; Olson, Alton; and Sigurdson, Sol. "Sex Differences in Mathematics Learning in a Canadian Setting". Canadian Journal of Education 6 (1981), pp. 5-19.

This study was made in conjunction with a province-wide mathematics assessment done in Alberta at Grades 3, 6, 9, and 12. Three basic questions were addressed: (i) do boys do better than girls in math at these grades?; (ii) do boys do better than girls in mathematics at all cognitive levels?; (iii) are the effects addressed in the first two questions related to differences in mathematics content? The results showed that the number of exercises on which boys did significantly better than girls was greater than the number on which girls did significantly better than boys. With regard to cognitive level, the number of exercises on which boys did significantly better than girls was greater than the counterpart figure for girls at each cognitive level. In considering all factors (grade, cognitive level, and mathematics content area), girls did better than boys in only three areas: Grade 3; knowledge level; number area.

Science Council of Canada. Who Turns the Wheel?. Proceedings of a workshop called "Science Education of Women in Canada", sponsored by the Science Council of Canada, 1980.

This report documents six papers presented at a workshop on why so few Canadian women are involved in science. It discusses the extent of the problem in Canada and the reasons why girls are not studying science. The roles of educators and policy makers as contributors to both the problem and the solutions are also discussed.

Smail, Barbara. "Spatial Visualization Skills and Technical Crafts Education". Educational Research 25 (November 1983), pp. 230-231.

This paper reports on an experiment that occurred at one of the schools in England involved in the Girls in Science and Technology Project. It suggests that spatial visualization skills might be enhanced by introductory lessons in technical drawing and three-dimensional work in wood and metal. A mixed-ability group of 18 girls and 12 boys received a 12-week course of technical crafts lessons on entry to secondary school at age 11 years. Their scores on a spatial visualization test increased significantly more than the 18 girls and 13 boys who received a parallel course of domestic subjects. This suggests that skills practised in technical crafts were useful in completing spatial ability tests. Questionnaires showed that the boys already had significantly more technical experience than the girls of the same age. Thus it can be argued that observed sex differences in spatial visualization scores are the results of environment rather than innate factors, and that they can be modified by experience.

Smail, Barbara; Whyte, Judith; and Kelly, Alison. "Girls into Science and Technology: The First Two Years". School Science Review 63 (1982), pp. 620-630.

Ten coeducational comprehensive schools in greater Manchester are involved in the GIST project. Two of the schools are control schools, where attitude and achievement tests are completed but no intervention is taking place. Patterns of sex difference in classroom behaviour, subject choice, and academic achievement are frequently accepted as a natural and unquestioned feature of school life. Consequently, it was neccessary to stimulate discussions which would lead teachers to recognize sex-role stereotyping. In the GIST program, a series of meetings were held with the science and craft teachers to discuss the problem of getting girls involved in science and technology, and to develop their own ideas for intervention strategies. Meetings were later held with all teachers in the schools. Inital tests on science knowledge showed little difference between the sexes. There were, however, sex differences in interest, with boys being more interested than girls in learning about physical science and girls being much more interested in learning about plants and animals. The most popular topic overall was human biology. It was suggested to the schools that one way to interest boys and girls in physical science might be to approach it through links with the human body (e.g., forces via muscles, light via eyes, and air pressure via lungs). Boys did better than girls on both the mechanical

reasoning test, questions on gears, pulleys, screws, etc., and on a spatial test. By age 11, boys are much more strongly sex-typed than girls, and have very definite ideas about what boys should do and what girls should do. They see science as a masculine subject and it is likely that they transmit this attitude to girls, making them feel out of place in a science laboratory. Intervention strategies involved visits to the schools by women working as scientists and technologists. Several teachers also planned "girls only" clubs in science, where girls could gain confidence in handling tools away from the possible ridicule of the boys.

Smithers, Alan, and Collings, John. "Co-education and Science Choice". British Journal of Educational Studies 30 (October 1982), pp. 313-327.

Research in England shows that girls in single-sex schools tend to be more successful than girls from mixed schools, and that fewer girls study science in coeducational schools. The most likely reason for this is that science becomes sex-typed and is dominated by boys in coed schools. This paper looks at the social structure of the school. Social class is significantly associated with subject choice among girls, with those from the higher social class backgrounds more likely to take the sciences. When ability and social class are taken into account, the overall difference reported between single-sex and coed schools largely disappears. High ability girls tend to make similar choices whether they go to single-sex or coed schools. Less able girls show a tendency to be more likely to study the arts at coed than at single-sex schools. Lower-ability girls from working class homes seem particularly unlikely to take physical sciences whatever the sex composition of the school. Lower-ability boys from working class backgrounds are much more likely to study the physical sciences. Differences in the number of boys and girls taking science persisted, even with ability and social class controlled for in the research findings.

Sylvester, Robert. "A Child's Brain". Instructor, September 1982, pp 92-96.

This article, the first part of a three-part series, discusses Dr. Herman Epstein's discovery of the cyclic nature of brain development. Epstein discovered that brain growth does not develop continuously at an even rate, but rather in four year cycles in which periods of rapid growth are followed by periods of slower growth. Brain growth occurs during six periods from the Kindergarten to Grade 12 level. The brain growth spurts for males and females occur at different times.

Whyte, Judith. "Observing Sex Stereotypes and Interactions in the School Lab and Workshop". Educational Review, 36 (1984), pp. 75-86.

It is a well-known fact that boys dominate mixed classrooms. They initiate more contacts with their teachers and are more successful in gaining teacher time and attention. Boys are perceived by teachers to be more rewarding and responsible students, even though they

tend to make unsolicited comments, call out in class, and ignore the "hands-up" rule. The aim of researchers working on the GIST project in England was to help teachers become aware of: (i) the way gender impinges on classroom interaction; (ii) the effects on the learning outcome for boys and girls; (iii) the possibility that laboratories and workshops were more male-dominated than regular classrooms; (iv) the extent to which positive change can be promoted. Results showed that most teachers were surprised to find how much attention they gave the boys. However, many were able to achieve parity of interactions with boys and girls, at least when an observer was present. Other factors discouraging girls from full participation in science labs and technical craft classes are also outlined.

III. SEX ROLES

Australia: Commonwealth Schools Commission. Girls and Tomorrow: The Challenge for Schools. Canberra: Commonwealth Schools Commission, 1984.

In 1974, the Commonwealth Schools Commission (Australia) sponsored an inquiry into the educational needs of girls and women. This prompted the individual state education departments to set up special committees to investigate sexism in education. Although this raised the awareness of the needs of girls, a decade later the quality of girls education still does not match that of boys in terms of developing confidence, self- esteem, and marketable skills. This report produced by a working party on the education of girls, established by the Commonwealth Schools Commission, is the first step towards a national policy on the education of girls. It focuses on school organization, curriculum, the role of the teacher, and the implementation of the recommendations. A review of recent Australian research on girls' education is included in the report.

Ballenden, Clarice. "Facing the Future: Careers and Girls". Occasional Paper No. 10, Victorian Institute of Secondary Education, Melbourne, Australia, March 1984.

Despite the recommendations in the School Commission Report "Girls and Society" (1975), few changes have been made. The curriculum still does not reflect women's experience. There are few role models for girls within the school system. Girls are less confident and ambitious than boys, and their choice of optional subjects reflects the traditional stereotype of women's role in society. This paper examines the way adolescent girls prepare for adulthood. It stresses the lack of realistic career planning and the conflict that exists between traditional and modern roles for women. Current school practice, and its role in reinforcing stereotypes, are analysed and strategies for change are outlined.

Best, Raphaela. We've All Got Scars: What Boys and Girls, Learn in Elementary School. Bloomington: Indiana University Press, 1983.

This book is the result of four years of intensive observation of one class of children at an elementary school in an affluent county in the United States. It shows how little girls become second-class citizens psychologically, socially, and sexually at the hands of a system run by caring adults. It shows how little boys become victims of a "macho" tradition, and how both boys and girls are socialized by our society and our school system to become incomplete people.

Delamont, Sara. Sex Roles and the School. London: Methuen, 1980.

This book argues that schools develop and reinforce sex segregation, stereotypes and discrimination exaggerating the negative aspects of sex roles in the outside world,

instead of trying to alleviate them. It looks at teachers and pupils of all grades, examining both the structure and the content of education to see how male and female roles are developed and reinforced.

Earley, Peter. "Girls, School and Work: Technological Change and Female Entry into Non-Traditional Work Areas". Australian Journal of Education 25 (1981), pp. 269-284.

This paper examines a number of issues related to the education and (un)employment of early female school-leavers. The relationship between "womens work" (as traditionally defined) and technological change is of special interest. The educational and vocational guidance given to girls is examined to determine if it is adequate at a time when the traditionally-female jobs are becoming scarce due to technological change. The extent to which females have entered non-traditional forms of employment, such as the skilled trades, is also examined. Some of the problems encountered by these students are discussed.

Evans, Terry D. "Being and Becoming: Teachers' Perceptions of Sex Roles and Actions Toward Their Male and Female Pupils". British Journal of Sociology of Education 3 (1982), pp. 126-142.

This article looks at the nature of teachers' perceptions of sex roles and sex-appropriate behaviours and whether these perceptions have changed in recent years. It was found that teachers' classroom practices continue to reinforce conventional sex-role stereotypes. Although the teachers considered themselves to be modern and liberal, their behaviour towards their students did not reflect this belief. They still see the female role as primarily concerned with motherhood and only secondarily with providing a second income. Both male and female teachers, especially the older ones, held conventional attitudes towards their students' future occupations. Female teachers had an ambiguity of self-concept in terms of their understanding of the role of women as both mothers and teachers.

French, Jane, and French, Peter. "Gender Imbalances in the Primary Classrooms: An Interactional Account". Educational Research 26 (June 1984), pp. 127-136.

This article is based on the verbatim transcription of a fourth-year junior school lesson with pupils 10-11 years of age. It is one of a series recorded as part of an ethnographic study of gender differences in primary classrooms. It is a well established fact that in a mixed-sex classroom male pupils receive more attention than do females. This study examines classroom interactions to find the reasons for these differences. In much of the recent research, the emphasis has been on teachers' favouritism of boys, but observations in this study suggest that both gender differences in teacher attention, and turn distributions among pupils, may be partly a result of groups of boys engaging in strategies to secure attention.

Kelly, Alison; Alexander, Juliet; Umar, Azan; Bretherton, Carol; Burgess, Gillian; Dorney, Alice; Gold, Julie; Leahy, Carolyn; Sharpley, Anne; and Spandley, Lynn. "Gender Roles at Home and School". British Journal of Sociology of Education 3 (1982).

The parents of 116 first-year pupils at an urban comprehensive school were questioned about their educational and occupational aspirations for their children, their views on sexual equality, and their children's "out of school" activities. Results showed their educational aspirations to be high, with little differentiation between the sexes. Occupational aspirations for the children were also high, and although they tended to be sex-stereotyped, parents generally were supportive of non-traditional choices. Although most parents were in favour of working mothers, equal pay, and men helping with housework, these attitudes coexisted with more traditional assumptions about men being the bread-winners and women being mainly responsibile to the children. The parents' own domestic labour and that which they required of their children were strongly sex-stereotyped. The message children receive about gender roles from their homes are contradictory, and not necessarily as traditional as many teachers assume.

King, A.J.C. "Boys and Girls". In The Adolescent Experience, pp. 98-109. Ontario Secondary School Teachers' Federation, 1986.

The data for this book were obtained from a survey of 60 Ontario secondary schools. The article looks at the differences in boys' and girls' attitudes towards their self-image, their friends, their teachers, and their school/future goals. Sex-stereotyping appears in their choice of subjects. Grade 13 boys are much more likely to take math, chemistry, and physics; girls are more likely to take languages and biology. However, girls achieve higher marks at all levels and in all subjects; they are more likely to enrol in the highest level of difficulty of courses; they are as career-oriented as the boys. Girls feel pressure to achieve in school and, although they do well, are more likely than the boys to feel that they are experiencing difficulty. Nine out of ten girls felt they could have both a career and a family. More boys than girls felt there were careers better-suited to males.

La France, Marrianne. "The School of Hard Knocks: Non-verbal Sexism in the Classroom". Theory into Practice 24 (Winter 1985), pp. 40-44.

The author argues that females in schools and colleges are touched differently by their teachers than are males in the same institutions, and that the touch directed towards the females is not always as benign as it might appear. Moreover, in reviewing the literature on gender and non-verbal communication she puts forward the thesis that touch is merely one of a several subtle non-verbal behaviours designed to keep women in a separate and unequal place.

Ricks, Frances A., and Pyke, Sandra W. "Teachers' Perceptions and Attitudes that Foster or Maintain Sex Role Differences". Interchange 4 (1973), pp. 24-33.

A survey of 60 secondary school teachers in Ontario was conducted in order to determine the nature of sex-role differences as perceived by teachers. The results revealed that teachers expected traditional male female student behaviour in the classroom, preferred male teachers and male students and were reluctant to facilitate sex-role behaviour changes. Evidence is given that males and females are socialized differently, maintaining traditional sex-role behaviour. Ways in which the education system can provide a new role balance allowing greater independence, integration, and freedom from misconceptions about the other sex is discussed.

Sadker, David, and Sadker, Myra. "Is the O.K. Classroom O.K.?". Phi Delta Kappan 66 (January 1985), pp. 350-361.

This study looked at 100 Grade 4, 6, and 8 classrooms in five American states. Observers spent a year in the classrooms. It was found that female students receive less attention than boys, and that classrooms are highly segregated both in seating arrangements and for group work. Teachers seemed unable to recognise this. Conditions were similar in classrooms with both male and female teachers. As part of the study, teachers in 67 classrooms received four days of training focusing on equity in classroom interactions. It was found that training can eliminate inequitable interactions and enable female students to participate at the sane rate as their male peers.

_____. Sex Equity Handbook for Schools. New York: Longmans, 1982.

In addition to providing an overview of the critical areas of sex equity in schools this book gives practical strategies for the elimination of gender bias in education. It considers the sex-role stereotyping of boys, girls, men, and women. A resource directory for sex equity in education is included.

Sampson, S. "Sex Stereotypes: Some Evidence from Australian Schools". Australian Journal of Education 23 (1979), pp. 132-140.

The attitudes and sex-role stereotypes of girls and boys at high schools with a female principal were compared to those at high schools with a male principal, to ascertain whether seeing women in leadership roles was related to greater acceptance of women's capabilities. Results indicate that significantly more boys than girls believe that women generally lack the characteristics necessary for leadership, regardless of the sex of the principal.

Smithers, Angela, and Smithers, A.G. "An Exploratory of Sex-role Differentiation Among Young Children". Educational Review 36 (1984), pp. 87-99.

This study shows that children of 6 and 7 years of age have already acquired a stereotyped and exaggerated view of what activities are appropriate for males and females. It was found that children viewed more activities as suitable for one sex only than did adults. Boys and men had stronger views on what boys, girls men, and women should do than did girls and women.

Stanworth, Michelle. Gender and Schooling: A Study of Sexual Divisions in the Classroom. London: Hutchinson and Co., Ltd., 1983.

This book discusses the way in which gender structures classroom interactions. It shows how boys and girls can sit together, study the same curriculum with the same teacher, and still leave school believing that the world is a man's world, in which women take second place. The book is divided into two parts. The first part traces the extent to which circumstances surrounding the choice of subjects, the curriculum, and teacher/pupil relations systematically undermine girls' abilities and confidence. The second documents ways in which gender divisions are sustained in mixed classrooms. This section is based on original empirical work. The research demonstrates that teaching practices serve to reinforce students' beliefs in male superiority.

Whyte, Judith. "Courses for Teachers on Sex Differences and Sex Typing". Journal of Education for Teaching 9 (1983), pp. 235-248.

The differential treatment of girls and boys by their teachers and schools leads to female underachievement. Yet few teacher-training courses include a comprehensive study of sex differences in education, or a discussion of sex-role stereotyping. Both these issues are of great concern to teachers. The initiatives that have taken place at Manchester Polytechnic for in-service and pre-service training of teachers are discussed.

_____. "Observing Sex Stereotypes and Interactions in the School Lab and Workshop". Educational Review 36 (1984), pp. 75-86.

It is a well-known fact that boys dominate mixed classrooms. They initiate more contacts with their teachers and are more successful in gaining teacher time and attention. Boys are perceived by teachers to be more rewarding and responsible students, even if they tend to make unsolicited comments, call out in class, and ignore the "hands-up" rule. The aim of researchers working on the GIST project in England was to help teachers become aware of the way gender inpinges on classroom interaction; the effects on the learning outcome for boys and girls; the possibility that laboratories and workshops were more male dominated than regular classrooms; the extent to which it is possible to promote positive change. Results showed that most teachers were suprised to find how much attention they gave the boys, but many were able to achieve parity of interactions with both sexes, at least when an observer was present. Other factors discouraging girls from full participation in science labs and technical craft classes are also outlined.

APPENDIX B: RESEARCH INVENTORY

CONTENTS

Section	Page
PREFACE	61
RESEARCH INVENTORY	63

PREFACE

This report represents the results of 285 questionnaires of which 146 were sent to the departments of education, psychology, and sociology at Canadian universities and to individuals who were known to be interested in computers in education. In addition, questionnaires were sent to 24 ministries and/or boards of education, 19 teacher federations and 6 women's groups in Canada, for a total of 195 questionnaires. Questionnaires were also sent to selected women's groups, universities and research institutes in the U.S., the U.K., Australia, and other countries where it was known that research had been done in the area of computers and education and/or gender issues in education. This accounted for a total of 90 questionnaires, 54 sent to the U.S., 15 to the U.K., 11 to Australia, and 10 to overseas countries.

Individuals and groups were asked to respond to questions about ongoing (or recent) research related to gender-equity issues in computer education. Response rates are shown in table 1.

Of the questionnaires returned, the greatest percentage received were from Canadian universities, school boards and teachers' federations. This is to be expected since the questionnaire to Canadian addresses included stamped addressed envelopes. Overall, 58% of the questinnaires sent to Canadian university departments were returned: 71% from departments of education; 62% from psychology departments; 46% from sociology departments. Twelve of these returned questionnaires indicated that research with some reference to gender differences and computer use was being undertaken, six in education departments, two in psychology and four in sociology. None of the questionnaires returned by women's groups, teacher federations, or boards of education indicated that research was being done in this area. The Quebec Ministry of Education is funding two studies: one to list the number of computer courses offered for girls and the number of girls taking those courses, and the other to ascertain from teachers their impressions of girls' interest in computers.

Overall the response from universities and research institutes outside Canada has been lower. Fifty-three per cent of the questionnaires sent to England were returned, with two positive replies. Of those sent to the U.S. there were four positive replies, or 49%, and of those sent to Australia there were two positive replies, or 55%. One positive return was received from the questionnaires sent to other countries.

The Research Inventory which follows offers a brief description of research reported by various groups and individuals who responded to the questionnaires. At the time of writing, these projects were still in progress.

Table 1

Response Rate to Survey

Target Group	Number of Questionnaires Sent	Responses	Research Projects Reported
Canada	195	104	16
University Departments *			
Education	37	26	6
Psychology	55	34	2
Sociology	52	24	4
Ministries/Boards of Education	24	10	4
Teachers' Federations	19	6	0
Women's Groups	6	4	0
U.S.A.	54	21	4
Britain	15	8	2
Australia	11	6	2
Other	10	2	1
Total	285	141	25

*Two were returned without identification.

CURRENT RESEARCH INVENTORY

Berthelot, Jocelyn. Centrale des Enseignants du Quebec, Ministère de L'Education, Québec. Study of Microcomputers and Teachers in School Boards. Funded by: Ministère de L'Education du Québec, Université Laval. Completion date: November 1985.

Two items on the questionnaire administered to the teachers relate to the issue concerned: (i) what is the sex of the teacher?; (ii) have you noticed less interest among girls in the use of microcomputers?

Cameron, Ann C. Psychology Department, University of New Brunswick, Fredericton. Children's Writing and Reasoning: Decontextualized Representation Using Microcomputers. Funded by: SSHRC; NB Department of Education School District #26; University of New Brunswick. Completion date: June 1988.

This is a longitudinal study of the use of microcomputers in primary education. Word processors will be used in language-related activities and the programming language Logo in mathematics problem solving. Sex differences are only an incidental factor of interest.

Collis, Betty. Department of Psychological Foundations in Education, University of Victoria. Ms. Collis has 2 research projects in progress:

1) A Comparative Study of Chinese and Canadian Secondary School Students' Attitudes Towards Computers. Completion date: October 1985.

A survey instrument designed to measure secondary school students' attitudes towards computers, mathematics, science, and writing was administered to 1,818 Canadian students and 299 Chinese students. The Chinese students attend five secondary schools in Shanghai, Peoples Republic of China. Preliminary analysis of the data indicates that the Chinese students show the same pattern of sex differences in attitudes toward computers as do the Canadian students. Opinions about computer use are not significantly different among Chinese males and females, but are significantly different for Canadian males and females. In particular, Canadian and Chinese females concur that women have as much competence in computer-related work as do men, while males in both countries tend to disagree that females have as much competence as men.

2) An Assessment of Attitudes Towards Computers in Young Children. Funded by: University of Victoria Faculty Research Grant. Completion date: June 1986.

The extent to which Kindergarten and first grade children view computers as being more appropriate for boys or girls is being assessed. Gender appropriateness with relation to reading and writing is also being studied. The change in any of these role associations

after an extensive language arts programme using microcomputer-delivered instruction is also a focus of the study.

Condry, John. Human Development and Family Studies Department, Cornell University. The Influence of Microcomputers in a Rural School District. Completion date: 1987.

This research, begun in 1984, looks at the general and specific effects of the large-scale introduction of computers into a predominately rural school district in Upstate New York. The following topics will be looked at: (i) attitude of students towards school and computers; (ii) effects of certain remedial computer programs on standardized test performances; (iii) the free-choice behaviour of students with computer software of various kinds; (iv) the influence of word processing; (v) the impact of telecommunication with other schools. Sex is one of the variables to be looked at.

Davidson, Maryellen; Ballenden, Clarice; and Firkin, Judith. Victorian Institute of Secondary Education, Melbourne, Australia. The Effect of Computers in Schools in Terms of Access and Equity.

Ongoing research on the use of computers in schools with particular reference to equity questions.

Erickson, Tim. Lawrence Hall of Science, University of California, Berkeley. Equals in Computer Technology: An Evaluation. Funded by: U.S. National Science Foundation. Completion date: September 1986.

This research is designed to assess the effectiveness of a 30-hour in-service program already presented to over 400 teachers in three western states. The principle focus of the in service program is to make teachers aware of gender-equity problems in computer education and to provide strategies and materials for equitable computer use. The research will focus on teacher attitudes, cognitive and effective gains of students exposed to the material, and an in-depth qualitative search for the attitudes of particularly effective EQUALS teachers.

Hoyles, Celia. Department of Mathematics Education, London University. The Logo Maths Project: An Extension of the Case Study Work into a Wider Network of Schools. Funded by: Leverhulme Trust. Completion date: Fall 1986.

This is a continuation of the preliminary investigation of the pupil-centred approach to the learning of Logo in the secondary school mathematics program (see Annotated Bibliography). It involves ten first-year mathematics classrooms taken from eight London comprehensive schools, including one all-girl comprehensive school and one all-boy comprehensive school. The purpose of the study is to look at the similarities and differences in response to the Logo activities in classrooms where the responsibility for the Logo

work is with the mathematics teacher, rather than the researcher. Sex is one of the variables to be examined.

Jackson, Owen. Supervisor of Research Services, Hamilton Board of Education. Enrolment by Sex and Computer Program Course by Grade.

This report lists the yearly enrolment of students taking computer courses at different grade levels by sex. Data go back to September 1983 and will be updated annually.

Kass, Heidi, and Kieren, E. Department of Secondary Education, University of Alberta; Egnatoff, B., and Higginson, B. Department of Education, Queen's University; Therrien, D. Laval University; Jeffrey, G.; and Spain, W. Memorial University. Micro-Electronic Technology and Canadian Youth: A Study of Access Values and Social Issues. Funded by: SSHRC. Completion date: Pilot Study: September, 1985.
Main Study: June, 1987 (if funded).

This nationwide study considers the nature and conditions of computer access for 10-, 13- and 16-year-old students. One important variable of comparison is the student's sex. Students will respond to a questionnaire; some will be interviewed and some observed using computers.

Klassen, Wendy. Department of Mathematics and Science Education, University of British Columbia. Gender Differences in the Use of Computers at the Grade 4 Level. M.A. Thesis. Completion date: September 1985.

A questionnaire was administered to a sample of Grade 4 classes. No strong differences were found, but some interesting trends are discussed.

Lees, Jessie. Faculty of Education, Dalhousie University. Girls' Avoidance of a High School Literacy Course. M.Ed. Thesis. Completion date: 1985.

A study of gender-related computer course enrolment. Such factors as the relationship of the computer with mathematics and males, parental and peer attitudes, perceived computer usefulness, were identified as having importance in a Grade 9 student survey.

Lévesque, Marie-Pierre, Coordination à la Condition Féminique, Ministère de L'Education, Québec. Interest and Availability of Courses in Computers for Girls in Primary and Secondary Schools. Funded by: Gouvernement du Québec. Completion date: March 1986.

This research will produce a list of computer courses which are open to girls at the primary and secondary school levels and will provide the number of girls taking these courses.

Mathews, Michael L. Deoartment of Psychology, University of Guelph. Interaction of Cognitive Style Sex and Mode of Presentation in the Acquisition of Word Processing Skills. Completion date: December 1985.

This research is examining whether user characteristics (e.g., cognitive style, sex) interact with the mode of presentation of commands in text-editing tasks. Specifically we hypothesize that users who have primarily a visual/spatial style will benefit from commands as ICONS, whereas those with a verbal/linguistic style will learn faster with commands as words.

Movshovitz-Hadar, Nitsa. Technicon-Israel Institute of Technology, Haifa, Israel. Teachers' Awareness of Sex Differences in the Use of Computers. Completion date: July 1986.

Workshops with kibbutz teachers of mathematics and/or computers will be given to raise awareness and decide what actions to take concerning problems related to sex differences in the use of computers.

Olson, John K. Faculty of Education, Queen's University. The Impact of Microcomputers on Classroom Life: Implications for Materials and In-service Design. Funded by: Ontario Ministry of Education. Completion Date: October 1985.

The main goals of this study are: (i) to determine the effect of microcomputer activities on how teachers think about their work; (ii) to learn how microcomputers affect social processes in the classroom; (iii) to find out what language teachers use to describe their use of microcomputers. Using classroom observations, video analysis, and teacher interviews, the researchers will report on the use of microcomputers in eight schools in the Ottawa area, focusing on Grades 4-9. Sex differences, if evident, will be reported.

Pancer, Mark. Department of Psychology, Wilfred Laurier University. Understanding and Predicting Computer Behaviours. Funded by: Internal sources. Completion date: October 1985.

This research uses Aizen and Fishbern's (1980) model of attitude formation and change to examine the effects of computer-related beliefs on intentions to use microcomputers and on facility with them.

Pretuk, M. Department of Education, University of Alberta (Project Director: Burnett, Dale) Department of Education, University of Lethbridge, IBM-University of Alberta Cooperative Project. Completion date: June 1988.

This project will examine the use of a cluster of IBM microcomputers in a junior high school over a three-year period. Sex differences will form part of this review.

Reimer, Gordon. Department of Curriculum, Brandon University. Effects of a Logo Programming Experience on Readiness For 1st Grade, Creativity and Self-Concept.
Completion date: Pilot Study: January 1985.
Main Study: January 1986.

The pilot study has already been completed and written. (see Annotated Bibliography). This showed that a Logo programming experience had considerable positive effect, with gains on ten of eleven dependent readiness variables. With regard to differences due to gender, a statistically significant difference was found in only one dependent variable: the gender effect on visual motor skills. The conclusion was that gender had little overall effect. In the one case where it did, females in both the treatment and control groups showed lower gains than males, but females in the treatment group showed higher gains than females in the control group. The study is to be repeated using a larger sample of students.

Schubert, Jane G. American Institutes for Research, Palo Alto, California. Girls' Computer Training Program Nets Award For American Institute of Research. Funded by: Women's Education Equity Act Program of the U.S. Department of Education. Completion date: December 1985.

AIR has developed a unique training program called SISCOM. This is an out-of-school computer learning program for young girls aged 9-14 years. It provides girls with the encouragement and hands-on computer experience they do not receive at home or at school. SISCOM's goal is to help correct the serious imbalance between male and female usage of computers and to make girls aware of computer career opportunities. The American Institute of Research is working with three Big Brother/Big Sister agencies to develop and test SISCOM's curriculum in California, Maryland, and Washington D.C. By the end of 1985 the program will be available to more than 400 Big Brother/Big Sister agencies and other civic organizations across the U.S.

Stahl, William, A. Department of Sociology, Luther College, University of Regina, The Social Impact of Information Technology on Higher Education in Saskatchewan and India. Funded by: SHASTRI; Indo-Canadian Institute. Completion date: July 1987.

A cross-cultural comparison of the social impact of computers and related technologies in university education. Sex differences will be looked at indirectly.

Strand, Dennis. Evaluation Unit, ACT Schools Authority, Australia. Evaluation of the National Computer Education Program in ACT Schools. Funded by: Australian Government (Commonwealth Schools Commission). Completion date: December 1986.

This is a national program in all states of Australia. The ACT (Australian Capital

Territory) evaluation carried out during 1985-86 is looking at all aspects of computer use, including sex differences.

Turkle, Sherry. Department of Science, Technology, and Society, MIT. Women and Computers. Funded by: IBM. Completion date: June 1987.

A study of the different styles of mastering computers and different meanings of computers for boys and girls, men and women.

Whyte, Judith. School of Education, Manchester Polytechnic. Girls into Science and Technology. Funded by: Equal Opportunities Commission; Schools Council; The Department of Industry; Shell (U.K.) Ltd. Completion date: The research is completed through data analysis and is likely to continue.

The aim of this research in a group of coeducational comprehensive schools in greater Manchester was to encourage girls to opt for science and technology and to investigate the reasons for the short-fall of girls in these subjects.

Wolfe, Sandra. Computers in Education Centre, Ontario Ministry of Education. Sex Equity/ Gender Issues in the Development of Educational Software.

In order to ensure that the software produced for the Ontario Ministry of Education is free of gender bias and has a wide appeal to both males and females, the researchers at the Computers in Education centre have produced a questionnaire to be used in the evaluation and field testing of all their software. This ongoing research will enable the researchers to identify those items that appeal to both boys and girls.